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REPORT OF THE CHIEF OF THE BUREAU OF BIOLOGICAL SURVEY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., August 30, 1929.

SIR: I have the honor to transmit herewith a report on the work of the Bureau of Biological Survey for the fiscal year ended June 30, 1929.

Respectfully,

PAUL G. REDINGTON,
Chief.

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

WILD-LIFE RESEARCH, CONTROL, AND CONSERVATION

The field of work of the Bureau of Biological Survey is briefly described by the term wild-life administration. This involves fundamental activities in research; direction of efforts for the control of species injurious to agricultural and other economic activities; and educational, regulatory, and administrative functions designed to protect and preserve harmless and useful species. The wild life coming within the province of the Biological Survey consists for the most part of vertebrate animals other than fishes, but biological surveys are conducted in basic field research that are broadly ecological and concern not only the mammals, birds, reptiles, and amphibians, but all other classes of native animals and plants that are indicators of the limits of the several natural life zones of the continent.

The Biological Survey was organized in 1885 to study the interrelationships of birds and agriculture, and in subsequent years the work was expanded to include investigations in the geographic distribution and the migratory and other habits of both birds and mammals. Detailed biological surveys were early undertaken, both on a state-wide scale and within definite natural regions covering parts of one or more States. It is from such biological investigations, though limited both as to specific groups and details of treatment, that the bureau was given its present designation.

The chief objects of the research work of the Biological Survey as now conducted are to ascertain the facts regarding the economic value, the distribution, habits, and abundance, and the relationships of the wild life of the country, with a view to the protection of useful species and those that are threatened with extinction under present-day intensive hunting and trapping and the steady encroachments of settlement and industry upon marshland, forest, and other areas essential to their perpetuation, and the control of injurious species. Control operations are not directed toward the extermination of any of the interesting native species of the wild life of the country but toward their local control when they become detrimental to farming, stock raising, or other economic interests, or to beneficial forms of wild life.

The importance of the work for which the Biological Survey is responsible is indicated not only by the increasing appropriations made by Congress for broadening the scope of its operations and enlarging its responsibilities, and the large amounts entrusted to it for expenditure in control work by cooperating States and organizations, but also by the varied services it renders in the dissemination of information through publications, demonstrations, and other methods to individuals, farmers' or-

ganizations, cooperating scientists, and institutions. Its research, service, and regulatory activities are concerned with the advancement of agriculture, stock raising, and forestry by the control of species that become economically injurious, by the protection and encouragement of useful species, by the propagation of suitable species in fur and game farming, and by combating maladies of wild animals and birds. The responsibilities of the bureau extend also to the maintenance of big-game and bird reservations and the administration of Federal wild-life legislation.

Although economic considerations should by no means be allowed to outweigh all others that are advanced for the welfare of wild life, they have a proper place in every measure considered for wild-life conservation, for man must in many places subdue nature and make it serve his purposes. Fields must replace large forest areas, and domestic livestock must supplant most of the wild ruminants, predatory animals, and injurious rodents. In the process whereby civilization, either intelligently or wantonly, is changing natural conditions, the wild life, wisely preserved and controlled, can be made an asset of great value, not only of economic but of esthetic and scientific importance, and the natural habits of many species may themselves be utilized in numerous ways, an example being furnished in the destruction of insects by birds.

The first requisite in wild-life administration is an adequate knowledge of the facts. Intricate problems are arising in the consideration of such matters as the provision of natural food supplies, the reservation of breeding areas, and the protection of wild species against their enemies. The people generally must be made more fully acquainted with the importance of these matters, as otherwise there can be no sound public policies affecting them. The history of game protection in this country was largely the story of uncoordinated action on the part of each of the several States until 1900, when Congress passed the Lacey Act. This act, extending the functions of the Department of Agriculture to include game protection, regulated interstate traffic in game birds and animals and pelts of fur bearers and importations of foreign species. It was followed in 1913 by the Federal migratory bird law, and in 1916 by the negotiation of the migratory bird treaty, under which the protection of the birds that pass between this country and Canada was made a Federal responsibility.

Wild-life administration requires competent leadership to accomplish results that will be satisfactory to economic interests, to conservationists and those interested in the esthetic phases of wild life, and to trappers and sportsmen. So far as the facilities provided for its work will allow, and with the cooperation of State conservation commissions, wild-life conservation associations, and individuals, the Bureau of Biological Survey is striving to meet its responsibilities in this great field. Competent administration of wild-life resources requires also technical knowledge well applied. It is dependent upon enlightened legislation, and this can be brought about only when the public is well informed regarding the needs and economic relations of wild life. Furthermore, it requires throughout the States a nonpolitical field force of high morale and esprit de corps, inspired by the magnitude of the achievement that is possible.

State and Federal agencies concerned with wild-life administration have both their own and interlocking fields. The Federal Government is charged with the duty of controlling injurious species of wild life on the public domain and, in cooperation with the States, is responsible for leadership in control operations elsewhere. It is responsible also for the conservation of the migratory birds of the country, both by the enforcement of restrictive legislation enacted for the purpose and by the creation and administration of refuges set aside as resting, feeding, and nesting grounds. In its research on wild life, its control operations, and its conservation activities, the Federal Government, through the Bureau of Biological Survey, supplements the efforts of each of the States to protect the species that live there and are enjoyed by its citizens. This work of the Federal Government can be successful only through the whole-hearted cooperation of the States and the people generally, and it may here be recorded that such cooperation is being extended in increasing measure. The preservation of useful and harmless species is a vast undertaking, and satisfactory solution of the intricate problems involved in wild-life welfare will redound to the credit of all who have any part in the cooperation. The ultimate objective of wild-life conservation organizations will be achieved only through a continuation of the harmonious effort that was so

greatly in evidence during the year and resulted in the enactment of the measure known as the migratory bird conservation act.

IMPORTANT ACCOMPLISHMENTS OF THE YEAR

Among the accomplishments of the year that are of outstanding importance in wild-life research, control, and conservation, or in progressive legislation for promoting conservation programs, may be mentioned the following, the details of which appear in later pages of this report:

Enactment by Congress on February 18, 1929, of the migratory bird conservation act, which has been termed one of the most important measures for the protection of wild life that have been written on the statute books of any nation. First steps were taken during the year looking to the acquisition of lands authorized thereunder for refuges for migratory birds, the need for which was stressed in last year's report.

Completion of engineering studies for improving the extensive marshes at the mouth of Bear River, Utah, as a refuge for migratory birds and as a means of checking the serious losses hitherto occasioned by alkali poisoning, and solicitation of bids for beginning the construction of the necessary dikes and river-control works.

Submission to Congress in accordance with a proviso in the appropriation act for 1929, of a proposed 10-year program of predatory-animal and rodent control on national forests and other public domain and elsewhere, in cooperation with State organizations.

A decided advance in knowledge of the diseases of elk in the southern Yellowstone region, which have caused serious losses hitherto attributed mainly to starvation in winter.

Completion in cooperation with a committee of eastern sportsmen of a 5-year investigation of quail production in southern Georgia and northern Florida, as a result of which important recommendations have been made for increasing the abundance of quail, including such measures as control of natural enemies and improvement of habitat and methods of propagation.

Determination of the breeding period of the marten, after a series of investigations conducted at the fur-animal experiment station in the Adirondack region, New York.

Determination of the fact that the so-called "distemper" of foxes in captivity covers at least four diseases, methods for combating which were improved during the year.

Increased cooperation with the States in predatory-animal and rodent control as evidenced by the promise of cooperative funds totaling $1,800,000 for the current year, as compared with $1,120,000 expended during the year just closed, and the addition of five States to the list of those cooperating.

Beginning of predatory-animal control operations in Alaska in cooperation with the Territorial Government, based on studies made during the previous year, and first effective work to check the spread of coyotes in the Territory, which will aid in protecting the birds, big-game animals and fur bearers, and the herds of reindeer.

Stimulus to control operations against jack rabbits in Western States by aiding farmers in finding a market for the pelts, which, in addition to ridding crop and range areas of millions of the destructive rodents, netted farmers and stockmen approximately $2,000,000 from the sales of pelts.

ORGANIZATION

A detailed outline of the organization of the bureau and of the functions and purposes of its field offices was presented in Miscellaneous Publication No. 49, Directory of Field Activities of the Bureau of Biological Survey, issued just before the close of the fiscal year.

Shortly after the passage of the migratory bird conservation act the Secretary authorized the creation in the Biological Survey of a Division of Land Acquisition, and preliminary steps were at once taken to organize the unit so that it might be ready to function under the new law at the beginning of the fiscal year 1930. This division has immediate supervision of all activities in the matter of examining, classifying, appraising, surveying, and acquiring wild-life refuge lands by purchase, lease, or gift, and by Executive order, not only under the new act but under other similar laws. Work of this nature under the Upper Mississippi River Wild Life and Fish Refuge act and the Bear River Migratory Bird Refuge act was taken over by the new division when it was created. It will also be a function of this division to conduct surveys incident to the establishment or enlargement, and the definition of boundaries, of all refuges maintained by the Biological Survey. Rudolph Dieffenbach has been placed in charge of the new division, the personnel of which has had long and varied training and experience in all

phases of land-acquisition work, including boundary surveys, soil classification, and land valuation.

A specific appropriation for carrying on the work of the unit concerned with fur farming and a description of its functions are contained in the agricultural appropriation act for the current year. This action was taken by Congress following requests of national associations of the fur industry, representative fur farmers, rabbit breeders, and fur tradesmen, and on recommendation of the department. The production of fur animals was first made a project of the Biological Survey in 1913, and the establishment of a separate Division of Fur Resources was authorized by the Secretary in 1924.

In order to describe more adequately the work of the division charged with control-methods research and cooperative control campaigns, its designation has been changed, effective July 1, 1929, from Division of Economic Investigations to Division of Predatory-Animal and Rodent Control; and the three major projects under the division will be designated control-methods research (with a laboratory at Denver, Colo., known as the control-methods research laboratory), control of injurious rodents, and control of predatory animals.

It is appropriate to record at this point the publication in January of a monograph by the Institute for Government Research, of the Brookings Institution, entitled "The Bureau of Biological Survey: Its History, Activities, and Organization." The author, Jenks Cameron, presented very fully without criticism or recommendations the history of the bureau, its functions, by detailing specific activities, its organization, the nature of its plant, a compilation of laws and regulations governing its operations, its appropriations and expenditures from year to year, and a full bibliography of all sources of information bearing on the bureau and its operations, including a reprinting of a 29-page mimeographed leaflet (Bi–982) issued by the bureau during the year listing all of its publications issued from the time of its establishment.

BIOLOGICAL INVESTIGATIONS OF WILD LIFE

Investigations of the geographic distribution, migration, classification, and natural history of wild animals, of animal ecology, and of the natural life zones provide many of the fundamental scientific facts essential to the administration of the wild-life resources of the country. Field studies were made of the life histories, abundance, natural requirements, and diseases and parasites of big game and other mammals and birds, the purpose being to provide a basis for improving their welfare, controlling excessive numbers, or transplanting suitable species for restocking depleted areas.

Special attention was given to problems concerning North American waterfowl, the elk herds of Wyoming, and the deer on the Kaibab Plateau, Ariz., and in Pennsylvania and Virginia, and observations also were made regarding moose, mountain sheep, antelope, caribou, and reindeer. Specimens of the bird and mammal life assembled in the extensive collections of the bureau afforded the basis for revisions of genera, for reports on special regions, and for the identification of forms involved in administrative, regulatory, and control work. Much of the work was conducted in cooperation with scientific and educational institutions.

RESEARCH ON BIRDS

In ornithological research, taxonomic, distribution, and migration studies were made and many specimens were recorded and added to the collection. The number of bird specimens now in the collection is approximately 65,000. During the year 400 birds were identified for correspondents and museums, and assistance was given the American Ornithologists' Union in the revision of its check list of North American birds.

Through the financial aid of a cooperator interested in the birds of Florida, a careful survey was made of the breeding birds of the northern and central parts of the State, and information of much value was thus obtained for use in a report on the birds of Florida, which is now ready for publication. Reports on the results of ornithological research published during the year included a circular (No. 40) on the spread of the European starling in North America; a treatise prepared in the bureau and published by the Biological Society of Washington on birds of the Washington, D. C., region; and an extensive work on the birds of New Mexico, published under the auspices of the New Mexico Department of Game and Fish. Publication of this important volume was made possible by the generosity of interested residents of the State, who underwrote the cost of printing and colored illustrations.

CENSUSES OF MIGRATORY WILD FOWL

Investigational work has been continued by means of waterfowl censuses to provide information regarding the numbers, distribution, and migratory movements of the ducks, geese, swans, and coots of North America, as a basis for administrative action regarding open and close seasons, bag limits, and other regulatory matters with which the Biological Survey is concerned under the provisions of the migratory bird treaty act. This has included field work by members of the staff and the collation of monthly reports on observations made by about 4,000 volunteer cooperators on areas selected as typical of waterfowl conditions in the United States, Canada, and Newfoundland. The waterfowl census work has continued to grow as additional observers have been enlisted, and Federal and State officials in the United States, and Dominion and Provincial officials in Canada and Newfoundland, have participated actively in organizing and conducting the work. Approximately 20,000 monthly reports on waterfowl conditions were received during the year, and comparison of the results with those of previous years shows their increasing value in affording information regarding the distribution, the seasonal and regional movements, and the increases or decreases of waterfowl.

BIRD-BANDING STUDIES

Bird banding, which has been further developed during the year as a means of obtaining information regarding the migratory movements and abundance of waterfowl, is of particular importance in working out the routes, the resting and feeding areas, and the points at which the various birds breed and winter. In cooperation with the American Wild Fowlers and the National Association of Audubon Societies studies were begun on bird refuges in Louisiana to determine methods of banding blue geese and canvasback ducks on a large scale. The ultimate results should be important in filling the gaps in our knowledge of these species.

The total number of ducks and geese banded up to the close of the fiscal year was 41,989, of which more than half, or 21,557, were mallards. Other species that have been banded in fairly large numbers were black ducks, 6,973; pintails, 6,218; blue-winged teals, 1,565; and green-winged teals, redheads, ringnecks, and lesser scaups with close to 1,000 records each. Localities where 100 or more migratory waterfowl have been banded now number 56, and are fairly well distributed from Alaska and southern Canada to southern California and the Gulf coast. Realizing the importance of these studies, many sportsmen have reported on banded wild ducks that were killed.

In addition to 29 active waterfowl-banding stations, more than 1,500 trapping stations were maintained by licensed cooperators for banding miscellaneous species of migratory birds. This work serves as a valuable supplement to the results obtained with waterfowl, as it affords information that is needed on practically all groups of North American birds in studying the general principles governing their migratory movements. Bands purchased and issued during the year totaled 249,000, and birds reported as banded in this period numbered 133,884, including 11,132 waterfowl, bringing the total number banded since 1920, the year the work was first organized, to well over half a million.

Manuscript for a manual for bird banders was in press at the close of the year, detailing with abundant illustrations efficient banding methods, and its publication will be of great help to cooperators in the project. Indicative of the widespread interest in this method of bird study are the publication by the American Ornithologists' Union of a bibliography of bird banding in America, in which are listed more than 500 titles of papers published on the subject, and the publication in the Proceedings of the Sixth International Ornithological Congress held at Copenhagen, Denmark, of a paper on bird banding in America, both of which were prepared in the bureau.

RESEARCH ON MAMMALS

In mammal research, work was continued on a general report on the mammals of Wisconsin, on taxonomic revisions of the ground squirrels of North America and on a report on the mountain lions of both North America and South America, and on the collating of the results of field surveys conducted some years ago on the mammals of Lower California. A catalogue of type specimens of mammals in the United States National Museum, including the Biological Survey collection, is being prepared. Assistance has also been given to vis-

iting scientists who were working on special problems involving the use of the bureau's records or collections. Indicative of the demand for assistance is the fact that information has been supplied on request to the following Government offices in Washington, in addition to other bureaus of the department: The Public Health Service, the public schools of the District of Columbia, the Metropolitan police of the District of Columbia, the Office of Public Buildings and Public Parks of the National Capital, the National Park Service, the National Museum, and the National Zoological Park. Mammal specimens to the number of 831 were identified for 37 institutions or individuals, representing 22 States and 2 foreign countries, and a considerable interchange of specimens was made between the Biological Survey and other research institutions for use in special studies. The mammal specimens in the Biological Survey collection now number approximately 131,000.

One number of the North American Fauna (No. 52), Revision of the American Chipmunks, Genera Tamias and Eutamias, and a technical bulletin (No. 145) on Life History and Habits of Grasshopper Mice, Genus Onychomys, were in press at the close of the year. Manuscripts of reports on the mammals of New Mexico, the mammals of Oregon, the mammals of Yellowstone National Park, pocket mice of the Northwest, and the pocket gophers of the United States were completed for publication, and a circular, Studies of Mammalian Life Histories, was revised for reissue. Work was continued also on an account of the life history and taxonomic status of the caribou, including careful comparison with Biological Survey collections of all specimens in the National Museum in Washington, the American Museum of Natural History in New York City, the Academy of Natural Sciences of Philadelphia, and the Field Museum in Chicago.

INVESTIGATIONS OF DEER

At the request of the State game commission, the bureau has continued to cooperate in studies of factors affecting the deer in Pennsylvania. This has included field investigations and the submission of detailed reports on conditions as found. The game commission has published these reports to use as a basis for educational work and administrative action in the management of the deer, including the fixing of open seasons. At a conference called by the game commission at Harrisburg, Pa., a member of the bureau was designated to serve as leader of a committee then selected to make a thorough fact-finding investigation regarding conditions affecting the deer, including the various causes of mortality, possible malnutrition or starvation, weakening by parasites or diseases, and of the nutritive value or possible toxic properties of plants eaten by deer. The committee includes representatives of the State Bureau of Animal Industry, the State Agricultural College and Experiment Station, and Bucknell University.

At the request of the commissioner of game and inland fisheries of Virginia, representatives of the bureau made a preliminary survey of the abundance of deer in three counties in the western part of that State, and of the various factors affecting them, including available food and depredations by predatory animals, particularly bobcats. The report, with recommendations for bettering conditions, was published by the commission, which is taking steps to put into effect the management practices recommended.

Two representatives of the bureau took part also in a study made during the spring of conditions affecting deer on the Kaibab Plateau, north of the Grand Canyon, Ariz., in cooperation with representatives of the Forest Service of this department, the National Park Service of the Department of the Interior, and the State game department of Arizona. Observations were made on the numbers of the deer, their condition at the close of the winter, the extent and causes of mortality among them, and the effect of their browsing and grazing on forest trees, and forest reproduction, and the available food supply.

ELK INVESTIGATIONS IN WYOMING

Losses of elk at the refuge in Jackson Hole, Wyo., were found comparatively light during the winter, particularly among the fawns. Many of the animals wintered successfully on the natural ranges, and the feeding season was therefore short and the losses few, only 76 elk having died on the refuge, as compared with 409 during the previous winter. The major cause of the loss continued to be necrotic stomatitis. The findings thus far have made it possible to improve the management of the herds and the selection of winter food, to the betterment of the health of the animals.

Particular attention has been given to a study of the factors governing the increase or decrease of the southern Yellowstone elk herd, and the work has been coordinated with investigations of the northern herd through cooperation with the National Park Service. In addition to the intensive work upon diseases, arrangements have been made to ascertain the annual kill by hunters and the extent to which predatory animals may be responsible for losses, particularly among the fawns.

Careful observation is being made of the herds while feeding, and the findings are proving of much interest and importance. Following this, intensive studies are made of the plants present on the feeding area and the extent to which the animals have grazed upon them. These studies deal with the palatability of the various plants, the discrimination displayed by the animals in feeding upon certain kinds and leaving closely related species untouched, and, through cooperation with the agricultural experiment station of the University of Wyoming, with chemical analyses of plants, including representative species of both winter and summer forage. Material from elk licks also is being analyzed in order to learn definitely what mineral constituents attract the animals.

Important information is being obtained regarding the general condition of the elk, their numbers, their various habits or traits, and such physical features as size, weight, and rate of growth. This work is being conducted along ecological lines, to bring into the record essential information regarding the interrelationships of all members of the flora and fauna of the region, including the activities of various rodents and predacious animals and birds. Motion pictures were made to illustrate important features in the life history and behavior of the elk. Attention also has been given to other big-game animals of the locality, including mule deer, moose, and mountain sheep.

WILD-LIFE RESEARCH IN NATIONAL FORESTS AND PARKS

Arrangements were nearly completed for undertaking a program of research in the relationships that birds, mammals, and other vertebrate animals sustain to forestry development, a study made possible by the provisions of the McSweeney-McNary Forestry Research Act. A representative of the Biological Survey attended the annual meeting of the Appalachian Forest Research Council at Asheville, N. C., and outlined a program of experiments and investigations of the life histories and habits of the various forest-inhabiting species, to ascertain their beneficial and injurious relationship to forest resources and their value as forest products. Preliminary field investigations were made at a number of points in this experiment-station district, and other measures were taken for launching the work effectively during the coming fiscal year. An article showing that wild animals affect forest production in many ways was published in the Yearbook of Agriculture, 1928.

Studies were continued in the Grand Canyon National Park and surrounding territory in cooperation with the Carnegie Institution of Washington, the National Academy of Sciences, the National Research Council, the National Park Service, and the Forest Service. A field naturalist was engaged upon this work during May and June to make extensive collections of specimens, study the life history and habits of animals, and determine the life zones of that region, including San Francisco Mountain. The results will be of great value in the comprehensive educational program that is being carried forward by the cooperating agencies to assist the visiting public in appreciating and profiting from the remarkable natural phenomena of this region.

REINDEER INVESTIGATIONS IN ALASKA

Studies in progress for the improvement of the Alaska reindeer are concerned primarily with herd management, breeding experiments, including crossbreeding of reindeer and caribou, disease and parasite control, forage resources and grazing practices, range recovery from overgrazing and fires, and the utility of various cultivated feeds grown locally. In these studies close contact is maintained with firms and individuals engaged in producing reindeer in the Territory and with officials of the Bureau of Education of the Department of the Interior, which is concerned with the production and use of reindeer by the native population. A statement was issued in February by a joint committee of the Departments of Agriculture and the Interior on the status of reindeer meat, showing that it is not included under the Federal meat-inspection act, but that when shipped interstate and marked for identification, it may be handled in federally inspected plants.

Injury to reindeer and reindeer products by warble flies, nose flies, and

other insects, occasioning an aggregate loss to producers of many thousands of dollars annually, caused the Alaska Legislature at its recent session to appropriate $10,000 to assist the bureau in determining means of relief. A mimeographed leaflet (Bi–1012) on reducing the number of warble and nose grubs in reindeer was issued in March. A cooperative agreement was completed between the Bureau of Biological Survey, the Bureau of Entomology, and the Territory of Alaska, through the governor, for procedure to be followed in the investigations. In June an expert entomologist was detailed by the Bureau of Entomology to undertake a thorough study of the life history and habits of these parasitic insects and their relationship to reindeer, and to develop methods of control.

The Biological Survey maintains a reindeer experiment station of about 1,200 acres near Fairbanks and a substation for the western coastal area at Nome. Under its jurisdiction also is Nunivak Island, which was set aside by Executive order of April 15, 1929, for use in conducting experiments in the crossbreeding and propagation of reindeer and native caribou and for contemplated experiments in reestablishing musk oxen in Alaska. The crossbreeding experiments with caribou and reindeer were begun on Nunivak in 1925, and this reservation will insure protection of the experiment and facilitate its orderly progress. The capture of caribou during the year by roping from canoe and power boat during their migration across Harding Lake, near Fairbanks, has afforded a means of obtaining animals for experimental work.

Progress was made in reindeer-feeding experiments, and a cooperative agreement was entered into with the Bureau of Animal Industry to conduct intensive studies of the nutritional problems involved in the use of the various available types of feed by both caribou and reindeer. The Bureau of Chemistry and Soils has aided materially by making analyses of forage plants.

Meteorological instrument stations for the study of moisture and climate in relation to reindeer and plant growth were established at three points: Nome, on the Bering Sea coast; near Fairbanks, in the Tanana Valley of the interior; and in Broad Pass, on the Alaska Range. These stations, situated in typical areas, will prove exceedingly helpful in studying the varied climatic conditions affecting the animals and the forage growth throughout Alaska.

The facts deduced in the reindeer investigations, and the conclusions thus far reached, are providing a sound foundation for improvement in the reindeer industry. Reindeer production furnishes a means for the efficient utilization of the vast forage yield of Alaska; it is important to the social and economic development of the native people, and with further development may provide a market for grain and hay raised by local farmers. A circular (No. 82), Improved Reindeer Handling, was in press at the close of the year.

RESEARCH ON FOOD HABITS OF WILD LIFE

LABORATORY INVESTIGATIONS AND STOMACH ANALYSES

FOOD OF BIRDS

The main investigations during the year on the food of birds did not take the usual form of research on specific problems but consisted mainly of special examinations of groups of birds from different parts of the country on the request of various individuals and institutions interested. One lot of stomachs examined consisted of those of more than 50 ruffed grouse and a few ring-necked pheasants, information on the food of which was desired by a committee making an investigation of ruffed grouse in New England, with which the bureau is cooperating. Other special examinations concerned the feeding habits of fish-eating birds, jays, and woodpeckers, from California; butcher birds, collected to round out data in connection with the cooperative quail investigation in Georgia; birds from Florida supposed to be feeding upon the celery-leaf tyer; jacksnipe, from Wisconsin, to determine the extent of their vegetable food; and a variety of insectivorous birds, collected in Montana, to learn their relation to the mountain pine beetle.

A few miscellaneous stomach examinations of migratory birds were made to learn whether the protected status of these birds under the migratory bird treaty act should be changed. The care of reference collections of insects, seeds, skeletons, and other material used in identifying the stomach contents of birds and other species being studied was made a special feature of this part of the work. The seed collection now contains representatives of more than 3,000 species.

There was published during the year a farmers' bulletin (No. 1571) on the European starling, with suggestions for control measures when necessary. A comprehensive report was completed for publication on the English sparrow in the United States, intended to reflect the present economic status of the bird, as well as a leaflet on recommended measures of control.

USEFULNESS OF HAWKS AND OWLS

In the spring of 1927 the game commission of Yakima County, Wash., established a bounty on various predatory species supposed to be destructive to useful birds, especially to upland game birds. Arrangements were made for the preservation of the stomachs of hawks and owls killed and presented for bounty, and 121 of these, 5 kinds of hawks and 2 of owls, were forwarded to the Biological Survey for study. Of 45 stomachs of Swainson's hawks, 40 containing food held about 90 per cent ground squirrels, the remainder consisting of snakes and grasshoppers and other insects. Of 31 of red-tailed hawks, 27 held food, of which 83 per cent was ground squirrels, 6 per cent rabbits, 4 per cent meadow mice, and the remainder snakes. These hawks and owls, for the killing of which a bounty was paid, had been preying chiefly upon ground squirrels, rabbits, and mice, species so destructive in the Western States that the Federal Government and the States have been cooperating for years in campaigns to control them. No game birds whatever had been eaten by any of the 121 hawks and owls killed, and only 3 birds of any kind. It is gratifying to be able to record that as a result of the findings of the Biological Survey bounties on hawks and owls are no longer paid in Yakima County.

FOOD OF OTHER VERTEBRATES

The principal item of laboratory work upon vertebrates other than birds was examination of the following mammal stomachs: 25 of harbor seals from Washington State, to learn their relation to the fishing industry; 33 of prairie dogs from Arizona, collected to show the relation of these animals to forage for livestock; and a lot of more than 80 miscellaneous species from North Carolina, information on which was desired to show the relation of the animals to reforestation. In addition a few examinations were made of stomachs of reptiles. At the close of the year a technical bulletin (No. 147) on the habits and economic status of the alligator was in press.

FIELD INVESTIGATIONS OF SPECIES REPORTED INJURIOUS

BIRDS AND MAMMALS IN RELATION TO FRUIT AND BULB PRODUCTION

There has recently arisen considerable agitation in California for the suppression of bud-eating and fruit-eating birds. Two representatives of the bureau were detailed to investigate the situation, and it is hoped thereby to obtain results that will be satisfactory both to the fruit growers and the bird lovers. Some years ago a similar request was investigated and the results published in bulletins of the Biological Survey.

Further investigations of field problems in the food habits of wild animals concern the relation of moles and rodents to the expanding bulb-growing industry in the Pacific Northwest. This work has been carried on for three years and sufficient information is now at hand for the preparation of a report. Investigations also were made of the relation of bats to the codling moth in the Northwestern States.

FOOD HABITS OF RODENTS

Progress was made on studies of test areas in Arizona to ascertain the destructiveness of various rodents to forage and to compare the condition of plots to which rodents only, cattle only, both rodents and cattle, and no grazing animals had had access. This work is just now entering a new phase in which the rate, quantity, and quality of recovery of the vegetation following operations for the control of prairie dogs will be studied. Not only is destruction of forage involved, but since denuded lands are more subject to erosion, the effect of rodents in increasing erosion is being measured. A manuscript on the habits and economic relations of the southwestern porcupine was nearly completed during the year, and a farmers' bulletin (No. 1598), Mountain Beavers in the Pacific Northwest, was in press at the close of the year. Studies were continued of the food habits of pocket gophers and a report completed for publication.

STUDIES OF BIRD-ATTRACTION METHODS

The experiments in attracting birds to the experimental chestnut orchard at Bell, Md., being carried on in co-

operation with the Bureau of Plant Industry, continue to yield good results from year to year. In 47 bird boxes erected on a tract of 2½ acres there were produced during the season of 1926, 17 partial or complete broods of birds, an average of 6.8 broods to the acre. In 1927, with the same equipment, the number of broods rose to 40, an average of 16 to the acre. In 1928, 52 additional bird houses were erected, making a total of 99, scattered over 3½ acres, and 65 broods were produced, an average of 18.5 to the acre. The kinds of birds and the number of broods of each in 1928 were as follows: House wren, 33; European starling, 9; English sparrow, 8; purple martin, 7; bluebird, 6; flicker, 1; and crested flycatcher, 1. This cooperation with the Bureau of Plant Industry is enabling the bureau to experiment in bird-attraction methods and is yielding valuable information in that field, as well as fulfilling the primary object of the studies—from the point of view of orchard management—namely, to increase the number of insectivorous birds in the locality.

In the line of bird-attraction methods, there was published during the year a leaflet (No. 36), Gourds for Bird Houses and Other Purposes, and an article for the Yearbook of Agriculture, 1928, entitled "Birds Can Be Attracted to Wood Lots by Various Measures and Practices."

DUCK MALADY IN THE WEST

Near the close of the fiscal year preliminary work was done in an investigation in Oregon of a destructive duck sickness that differs somewhat from that previously identified as alkali poisoning in the Bear River marshes of Utah. A field laboratory was established and necessary experimental pens constructed at Klamath Falls, Oreg., a promising center for the investigation. It is hoped with this early start, and with cooperation promised by specialists, to make even greater progress in the study of this malady during the present season than has heretofore been achieved.

FOOD RESOURCES OF MIGRATORY BIRDS

Studies were made of various areas from the standpoint of their food resources for wild fowl. One of these was at the mouth of the Chesapeake and Delaware Canal, in Maryland, where it was suspected that salt was damaging the duck-food plants. This suspicion proved to be unfounded. A study was made also of conditions on the St. Clair Flats, in Michigan, where it was apparent that the low-water level that had prevailed in the Great Lakes for several years was a factor unfavorably affecting the duck-food plants. At the time of the investigation and subsequently the water level had appreciably risen, and the condition of aquatic plants is greatly improved.

FOOD SURVEYS OF REFUGE AREAS

During the latter part of the fiscal year data were being gathered preparatory to undertaking studies of the wild-fowl food resources of areas for Federal migratory-bird refuges, and in the last month three parties were in the field actually engaged in the work.

The third season of intensive investigations of food plants on the Upper Mississippi River Wild Life and Fish Refuge was utilized to conclude a study undertaken principally to reveal the resources of the region as a feeding place for migratory wild fowl as well as the possibilities of improvement. Detailed reports have been made on local areas, and in this final year a general report summarizing the findings for the whole area was prepared. This included a full description of the aquatic and marsh flora, with special reference to factors controlling distribution, abundance, and development of food plants for wild fowl. In addition, information incidentally gathered was included regarding the birds, fur bearers, reptiles, amphibians, fishes, crawfishes, and mussels.

Studies were made at Detroit, Mich., also in connection with the proposed establishment of a refuge there for water birds. A report that was prepared on the aquatic and marsh flora of the Huron Mountain region of the Upper Peninsula of Michigan, with suggestions for improvements for the benefit of the wild fowl, was published during the year by the Huron Mountain Club.

INVESTIGATIONS IN THE PROPAGATION OF GAME BIRDS

COOPERATIVE QUAIL INVESTIGATION

During the concluding year of the cooperative quail investigation in southern Georgia and northern Florida efforts were concentrated on completing the various lines of study, examining stomachs of quail collected, and preparing the final report. At the close of the year the manuscript of the report was practically complete, and the cooperating sportsmen plan to publish it in book form.

OTHER UPLAND GAME BIRDS

In the course of the year's work preliminary arrangements were made for a proposed cooperative study of quail, ruffed grouse, introduced partridges and pheasants, and other game in the Middle Western States. Agreements covering the details of cooperation with officials of the State Universities of Michigan, Wisconsin, and Minnesota and the Sporting Arms and Ammunition Manufacturers' Institute have been signed, and it is probable that the investigation, the different projects of which are to be supervised and coordinated by a representative of the Biological Survey, will later be extended to other sections of the country.

An article was published in the Yearbook of Agriculture, 1928, entitled "Waterfowl Breeding a Necessary Adjunct to Protective Measures." The farmers' bulletin on Propagation of Game Birds has been revised and rewritten and the information will be published during the coming year in two parts: Farmers' Bulletin No. 1612 dealing with aquatic game birds, and Farmers' Bulletin No. 1613 on upland game birds.

INVESTIGATIONS IN FUR-ANIMAL PRODUCTION

FUR-FARMING INVESTIGATIONS

The developments in the production of fur animals on farms are due, in the main, to the increasing popularity of furs and the steadily diminishing supply of the animals in the wild. Under sound business and scientific management the profits derived from the sale of pelts are greatly stimulating the growth of fur farming, and interest in this field has been maintained also by prices paid for breeding stock. It is being demonstrated constantly that the natural supply of furs can be supplemented by raising fur animals under the care and protection of man. Fur farming, however, is not limited to raising the stock in inclosures, but utilizes large areas of land where the animals can roam at will. The business is steadily developing and has become a permanent form of land utilization. Lands used for fur farming are usually such as have little value for agriculture.

There are approximately 5,000 fur farms in the United States and Alaska, and between $20,000,000 and $25,000,000 is invested in the business. These figures do not include the vast areas of muskrat marshes in many parts of the country, many of which also are operated privately or by the States as fur farms. Growth in the fur industry has been accompanied by steadily increasing competition. In sections of the country where foxes and fox furs are not of the best quality, some producers have been crowded out; yet the business continues to increase. Approximately 80,000 silver-fox pelts were marketed in the United States and Canada during the past year. Fox farmers and their associations should study the significance of these facts and figures if the rapidity with which the business is developing is not to become a detriment to its progress through overproduction.

The pelts of fishers, martens, minks, otters, and raccoons generally bring high prices, and the skins are of fine and lasting quality. Their comparative scarcity has stimulated raising them in captivity. Mink, muskrat, and rabbit raising have developed more rapidly during the past year than have the other branches. The demand for young minks has exceeded the supply and the animals have commanded high prices. Muskrat-ranch owners in the East have shipped large numbers of live muskrats to the Pacific Coast States and to European countries for stocking marsh areas. That muskrat farming in marsh areas has become a profitable industry was shown in an article in the Yearbook of Agriculture, 1928.

Rabbit raising is now assuming large proportions as a minor agricultural business in various sections of the United States, especially in California and the Middle West. Large quantities of domestic rabbit meat have been sold in Los Angeles, San Francisco, Portland, and Seattle, though it has not yet been established as a staple in the majority of our large cities. The general public does not realize the value of rabbit meat in the diet even though it is relatively cheap, is of excellent quality, and can be prepared for the table in many ways. In cooperation with the Bureau of Home Economics, a mimeographed leaflet (Bi-1026) on cooking domestic rabbit was issued preliminary to the preparation of a formal publication on the subject.

Advertisements of large corporations selling fur animals have had both a good and a bad effect on the industry. That dishonest fur farmers and companies should use fur animals as a means of obtaining money from persons unfamiliar with the business is only to be expected, though deplored. Chambers of commerce, better-business

bureaus, the Federal Postal Service, fur-farmers' organizations, and fur-farming and fur-trade periodicals, however, have solicited the bureau's cooperation in bringing to the attention of the public the necessity of thorough study before investing, and the bureau issued a leaflet (No. 27), Recommendations to Beginners in Fur Farming, during the year.

Large numbers of fur animals are still taken in the wild, and the raw-fur harvest is worth to the trapper approximately $65,000,000 each year. The fact also that $31,000,000 worth of raw furs are exported annually is intensely significant to the farmer. Statistics on the fur trade show that the United States is now the greatest commercial fur-producing and fur-consuming country in the world. This was recognized by the Secretary in recommending that the invitation extended to this Government by that of Germany be accepted to participate in the International Fur Trade Exhibition and Congress, to be held at Leipzig, Germany, in 1930. Further development of the export trade can no doubt be fostered by participation with an attractive exhibit.

Prospective fur farmers and those already engaged in the business recognize that the bureau has available a fund of valuable information in this comparatively new field of agricultural production. Also, the Biological Survey is frequently called upon by representatives of foreign countries and by foreign fur farmers for information and guidance in planning and establishing fur farms and fur-animal experiment stations. Government representatives from England, Germany, France, Russia, Norway, Sweden, Czechoslovakia, Switzerland, and Estonia have visited the United States to study methods of breeding, feeding, and managing fur animals in captivity, and of treating fur-animal diseases and parasites, and on several occasions representatives of the bureau have accompanied them to its fur-animal experiment station or to private fur farms. Permission also has been granted upon request to translate department publications on fur animals into several foreign languages.

Demands are being made constantly that the bureau extend its operations to expedite its investigations. The desired results, however, can be accomplished only with adequate facilities for expansion, and these are lacking at present. Were they fully available, the bureau could better serve all who are interested in developing the fur resources of this country.

FUR-ANIMAL EXPERIMENT STATION

The research work conducted at the fur-animal experiment station maintained at Saratoga Springs, N. Y., has attracted the attention of fur farmers generally and of scientists in practically all countries interested in fur farming. Particular interest is being shown in the investigational work relative to the feeding and handling of fur animals. Of special appeal to fur farmers are the various methods of holding the animals in captivity, different types of dens and nest boxes devised to give satisfactory service, the effect of various rations on health of stock and quality of fur produced, and the cost of feeding. The bureau's investigations have made available accurate and comprehensive figures on the cost of feeding fur animals. During the year a mimeographed leaflet (Bi–990), A Comparison of Feed Costs with Pelt Values of Silver Foxes, was prepared to meet the demand for this information.

Fur-animal production does not yet have the background of scientific research that is enjoyed by the domestic livestock industries. Many fundamental matters, such as the breeding and gestation periods of the various species of fur animals, are still problematical. A definite accomplishment, however, has been recorded in the case of the marten. It has been generally believed that only during January and February could male martens be permitted to live with the females. Observations at the fur-animal experiment station have now demonstrated, however, that the normal mating season in the marten occurs during the summer months, usually between the middle of July and the third week in August, and not in winter, as had been supposed. The period between mating and birth therefore ranges from approximately 8½ to 9 months (259 to 275 days) instead of 60 to 102 days as has been heretofore believed. It has required many years' work for the bureau to establish the facts relative to marten breeding, because of an insufficient number of breeding animals. Observations are being continued along the same lines with martens and with badgers; and fishers and other fur bearers will be included when a sufficient stock is available for the purpose..

Practical tests in breeding and feeding have been conducted with red,

cross, and silver foxes, martens, and badgers. Badgers, the latest addition to the species kept at the station, were obtained by field men of the bureau in the course of work in predatory-animal control. Although badgers have been held only a short time at the station, investigations elsewhere have shown that they are adapting themselves to captivity and are producing young. The rabbit investigations at Saratoga Springs were discontinued and the stock shipped to California after the establishment of the rabbit experiment station at Fontana.

RABBIT EXPERIMENT STATION

The rabbit experiment station, established through the cooperation of rabbit breeders in the vicinity of Fontana, Calif., the local branch of the National Rabbit Federation, and the Bureau of Biological Survey, gives promise of exerting great influence on developments in rabbit raising. The year's work has been most successful, with the continued splendid cooperation manifested by the sponsors of the station and by rabbit breeders generally. The additional hutches and pens constructed during the year provide equipment to accommodate 600 experimental animals. Rabbit breeders in California, as well as in other sections of the United States, realize the value of this work and the relation it bears to the industry. A mimeographed leaflet (Bi–983) descriptive of the work and organization of the station was issued during the year.

Plans for five major feeding experiments with 125 rabbits were put into operation last August. At the end of the year there were 191 mature utility rabbits, 113 young available for additional experiments, and 26 rabbits representing fancy breeds. From 88 breeding does in two experiments, 1,182 young were produced, of which 752 were carried through the weaning period.

The experiments were somewhat handicapped by losses from an unknown malady, which reached epizootic proportions in many sections of California. Losses among domestic rabbits in the Pacific Coast States and in others were first noted in January, 1929, and soon thereafter were reported to the Rabbit Experiment Station as increasing rapidly. The station was besieged with appeals for help, but could do little during the year, as the personnel did not include a specialist on animal diseases, and laboratory facilities were not available. The cooperation of research workers in this field of the Universities of Minnesota and Southern California was enlisted, however, and valuable assistance has been received. It is planned to expand this line of research as rapidly as facilities are provided. Without adequate and authentic information on rabbit diseases, the industry is at a disadvantage, and large investments are being jeopardized.

Breeding and feeding experiments have been planned to determine the best and cheapest methods by which rabbits can be raised to marketable age, with profit from both meat and fur. In addition an experiment is in operation to ascertain the fertilizer value of rabbit manure, and a mimeographed leaflet (Bi–994) on the subject was issued during the year in cooperation with the Bureau of Chemistry and Soils.

Farm boys and girls in California have taken a keen interest in rabbits, and the director of the experiment station has assisted agricultural extension agents in organizing 4–H rabbit clubs. Invitations have been sent to the schools of California to visit the station, and boys and girls interested in 4–H club work have taken advantage of this to learn about the profits in the industry. An exhibit to demonstrate the work of the station was displayed and was well received at five fairs in California.

Three thousand persons visited the rabbit experiment station and about half as many the fur-animal experiment station during the year. Though not all were chiefly interested in raising fur animals, most of them took away much information on the subject.

FUR-ANIMAL DISEASES

Investigations in diseases of fur animals have been concerned mainly with studies of parasites and their control and epizootics on fur farms. Numerous critical tests were made to determine the value and safety of tracheal brushes in the treatment of foxes for the removal of lungworms. Results indicated that treatment in this manner once a month is fairly effective, even though the foxes are kept on more or less badly infested ground. To supply information requested by fox farmers a mimeographed leaflet (Bi–1010) on the treatment and control of lungworm trouble in foxes was issued, and at the close of the year a leaflet (No. 47) entitled

"Hygiene in Fox Farming" was in press.

Improved methods of handling diseased foxes during treatment have been devised, and studies regarding their tolerance to various drugs continued. To demonstrate safe methods of handling and treating fur animals a motion picture was made during the year at the fur-animal experiment station, entitled "How to Handle Foxes." It is designed primarily to interest veterinarians and to demonstrate the liability of serious injury in handling foxes unless the precautions recommended are taken. A short article was published in the Yearbook of Agriculture, 1928, entitled "Fur Farmers Aided by Research in Combating Outbreaks of Disease."

The cooperative research on diseases of foxes in captivity, which has been carried on jointly by the medical school of the University of Minnesota and the Bureau of Biological Survey since the fall of 1927, is most complete and comprehensive and has been made possible through coordination of field and laboratory investigations. Research workers representing the Rockefeller Foundation, the Mayo Foundation, the Pasteur Institute (Paris), and the Johns Hopkins University have become interested and are cooperating in their various fields.

The mortality rate of epizootic fox encephalitis, found to be a disease of both young and adult animals and to have fatal termination usually in a short time, has been materially reduced on certain experimental ranches by vaccination with ricinoleated virus. On other ranches where the vaccine was used as a protective measure no mortality was reported. Vaccination with three or four doses of the virus appeared to give a marked immunity from the disease.

In the present state of knowledge the term "distemper" is being commonly applied to more than one of several fox diseases. Thus far two epizootic diseases have been described for foxes, one an infection by a paratyphoid bacillus, and the other an encephalitis that apparently is not caused by a bacterium but rather by a filterable virus. During the year investigations revealed that foxes were subject also to broncho-pneumonia and tuberculosis.

In Alaska, in cooperation with the governor of the Territory, work in fur-animal diseases has been of assistance to the fur farmers. Lack of equipment, such as a fur-animal experiment station, experimental stock, and adequate laboratory facilities, handicaps the work on disease and other research in the production of fur animals in the Territory.

RESEARCH IN METHODS OF WILD-LIFE CONTROL

To bring injurious rodents, predatory animals, and other harmful species under control calls for constant research to determine the effectiveness of poisons and economical methods of using them. Research along these lines was carried on throughout the year at the bureau's control-methods research laboratory at Denver, Colo., and at various points in the field where actual control operations were being conducted.

A reorganization of the research work was put into effect during the year, whereby the laboratory was moved to larger and more suitable quarters to permit the installation of necessary equipment; the employment of a qualified chemist to work on the physical and chemical properties of various poisons in order to ascertain their fitness for use in the field; and prosecution of pharmacological studies to determine lethal dosages and the general effect of various poisons on the different animals. The territory in which field operations are conducted was divided into five districts, each under the direction of an investigator who makes careful observations on the acceptance of the different poisons by the various rodents and predatory animals and notes their toxic efficiency under natural conditions.

An improvement in control-methods research as a result of this reorganization is already evident. An illustration of the benefits derived is furnished by a rancher in Santa Clara County, Calif., who saved $4,300 by following methods recommended by the district investigator for the control of ground squirrels. This rancher had been prepared to use a fumigant in treating 4,500 acres at an estimated cost of $4,500, but as experiments showed that under prevailing conditions on the area it would have been highly expensive and unsatisfactory, a poison mixture employing specially prepared steam-rolled oats as the bait was recommended and used satisfactorily at a cost of only $200.

The laboratory also prepares special poisons in quantity for use in cooperative control campaigns throughout the United States. During the year an improvement was made by preparing predatory-animal poison in tablet form.

Although much has already been done to improve methods of control, there are several problems that require solution. For example, the fact that the Columbia ground squirrel of the Northwest and the California ground squirrel can withstand comparatively large doses of some toxic agents, and will not take certain baits, makes their control difficult and requires that more effective methods be devised. In the Southwest, also, a problem in control methods is presented because the jack rabbits there do not congregate in large numbers as they do in the Northwest. The control of pocket gophers also presents special difficulties in certain localities because of the variation in their habits.

During the year, as a result of research on control methods, a manuscript was prepared on the chemical and physical properties of thallium and its use in rodent control. A mimeographed leaflet (Bi–1028) was issued giving the results of various experiments to determine the effects on gallinaceous birds of rodent poisons. The experiments and field observations have proved that grouse, pheasants, quail, and domestic chickens possess a relative immunity from strychnine poisoning and that these birds are not likely to be harmed by eating rodent poison in which strychnine is used in the proportion recommended by the Biological Survey.

The development by the bureau of powdered red squill as a poison for rats has been of vast importance. The use of this poison, which has proved to be practically a specific for rats, has made it possible to carry on poisoning operations under circumstances that in the past would not permit the use of poison of any kind because of the danger to human life and domestic animals. A technical bulletin (No. 134), Red-Squill Powders as Raticides, was in press at the close of the year, and an article entitled "Rat Control Aided by Development of Effective New Poisons" was published in the Yearbook of Agriculture, 1928.

COOPERATION IN WILD-LIFE CONTROL

The economic importance of controlling injurious wild-mammal pests can not be overemphasized. Predatory animals, such as coyotes, wolves, mountain lions, bobcats, and some stock-killing bears, make serious inroads not only on domestic sheep, cattle, pigs, and poultry, but on the wild game animals and the ground-nesting and insectivorous birds of the country. Injurious rodents and other small mammals, such as ground squirrels, prairie dogs, jack rabbits, pocket gophers, woodchucks, porcupines, mice, native and introduced rats, and moles, cause losses in farm crops and range forage in the United States that run into the hundreds of millions of dollars annually. Since the inception of control work by the Biological Survey, cooperative campaigns have been more effectively organized and conducted each succeeding year. The success attained has been watched and approved by farmers, stock owners, and other cooperators, with the result that the bureau is continually urged to a further extension of the work. The campaigns have been followed by a marked decrease in the numbers of predatory animals and injurious rodents in the sections covered and by a corresponding increased production in farm crops and livestock.

Funds authorized in 1929 by States, counties, and other agencies for cooperation with the bureau in predatory-animal and rodent control for use during the fiscal year 1930, are indicative of the general popularity of the work. The amount thus authorized is in excess of $1,800,000, which is considerably more than for the present year and the largest amount the bureau has had since it began its cooperative control operations.

The policies and recommendations adopted at the conference of leaders in rodent and predatory-animal control, held last year at Ogden, Utah, have had a noticeable effect in bringing about better coordination and the adoption of more uniform practices, with resultant increased efficiency. Closer cooperation with the Forest Service and a better understanding between field forces have resulted from a letter addressed by the head of the Forest Service to all district foresters on the subject of cooperation with the Biological Survey in its predatory-animal and rodent control program. This letter points out that where rodents or predatory animals are found on national forests, the direction, control, and application of methods of eradication become the responsibility of the Biological Survey, and urges field men to perpetuate and improve this form of cooperation between the Biological Survey and the Forest Service.

Federal and cooperative funds available during the year permitted organized field work in the control of predatory animals and injurious rodents in 29 States. The Federal funds totaled

$559,239, of which $31,557 was used in control-methods research, $318,225 in the control of predatory animals, and $209,457 in the control of rodents and other small-animal pests. Cooperative funds from 17 of these States aggregated $357,210. In addition, cooperating counties, livestock and farmers' associations, and individuals contributed $1,036,969; bringing the total of cooperative funds to $1,394,179, of which $517,518 was used against predatory animals and $876,661 against rodents. The Federal funds and funds contributed by cooperating agencies and expended during the year under the leadership of the Biological Survey amounted to $1,953,418.

TEN-YEAR PROGRAM RECOMMENDED

The success thus far attained with the limited resources indicates the even greater accomplishments that might be expected if the bureau were equipped to carry out an adequate control program. Congress gave this matter consideration and as a proviso to the act making appropriations for the department for the fiscal year ended June 30, 1929, called for an investigation as to the feasibility of a cooperative program for the control of these wild-animal pests extending over five or more years. This investigation was made, and a report thereon recommending a 10-year program was submitted to Congress and printed as a House document (No. 496, 70th Cong., 2d sess.). Many farmers' and stockgrowers' organizations and other interested agencies have adopted resolutions urging that the program as called for in the report be put into operation.

CONTROL OF PREDATORY ANIMALS

Predatory-animal control operations were carried on during the year in all States from Montana to Texas and westward and also in South Dakota, Oklahoma, and Arkansas. Many requests were made for more extensive operations in the range States in which work is now being conducted and in other States, including Wisconsin, Michigan, Minnesota, New Hampshire, North Dakota, Virginia, West Virginia, and Missouri. Except in a temporary way and in a few instances, it has not been possible to meet these demands. One hunter was detailed from the South Dakota district to assist in the control of coyotes in Steele County, N. Dak., through an arrangement whereby the county paid the expenses. Similar arrangements are under way to assist in controlling bobcats and predatory bears in Virginia and West Virginia. Consideration is being given also to requests from Wisconsin and Minnesota, as it may be possible for State agencies to provide the necessary cooperative funds.

Cooperative arrangements for predatory-animal control in Alaska were continued during the year between the bureau and the Territorial government. Investigations disclosed serious destruction of deer, mountain sheep, and other big-game animals, fur bearers, and many of the game birds by wolves and by coyotes, which are extending their range in Alaska. The bureau expert detailed to the Territory for the purpose was able to work out satisfactory methods of attacking the problem. The Territorial legislature has appropriated $30,000 for the next biennium, and predatory-animal control will be carried on in cooperation with the Biological Survey, men trained in methods recommended by the bureau being employed to carry on control operations and to instruct native trappers and others interested regarding the best methods of destroying these pests.

Inability of the bureau to furnish hunters for work in all localities has led to a cooperative system in Wyoming, and to a less extent in Idaho and some other States, known as the farmer-hunter system, by which some type of service is possible for every responsible individual requesting it. Under this system a selected number of farmers and stockmen are given instructions and furnished with poison to work in districts that can not be covered by the salaried hunters, in this way supplementing to some extent the work of the regular force.

WOLVES AND COYOTES

The coyote is the most destructive animal on the western stock ranges, and also is a potential carrier of rabies and tularemia. Because of the menace of coyotes and the fact that when these animals are raised in captivity they frequently escape or are turned loose, the Oregon Legislature at its last session enacted a law prohibiting keeping them in captivity except in zoological parks. An outbreak of rabies among coyotes occurred during the year in the State of Washington, and to prevent serious losses additional hunters were

employed. Sporadic outbreaks of smaller proportions in Oregon, Nevada, and Colorado also called for control operations by field forces.

The gray wolf is no longer a livestock menace in States west of the one-hundredth meridian, although patrol work must be continued on the southern border of Arizona and New Mexico to prevent ingress of individual wolves from Mexico. The small red wolf of eastern Texas and adjacent territory, however, still commits serious depredations on livestock. The destruction of 1,043 of these predators in Texas during the year registers marked progress toward control.

An acute situation has arisen in Arkansas, particularly on the national forests, because of the increasing number of wolves there. Successful fire control on forest areas has permitted the growth of hardwood thickets dense enough to harbor the wolves and other predatory animals. On the Ouachita National Forest residents suffered such heavy losses of livestock from wolves that woods burning was considered as a measure to drive out the predators. In such cases there is need for quick and effective control operations so as to make recourse to forest burning unnecessary. In one district of the Ozark National Forest in 1927, wolves killed more than 1,600 hogs, pigs, sheep, and lambs, valued at $4,600, and inflicted similar losses in other areas.

Action tending to relieve the situation became effective at the beginning of the fiscal year, when a formal agreement for predatory-animal control operations was entered into between the bureau and the Arkansas State game and fish commission. Actual field work began in August, 1928, in connection with operations in Oklahoma, which were started at the same time, and during the ensuing 11 months 352 wolves as well as other predators were taken. As a result many letters of commendation have been received from farmers in the two States.

The total number of coyotes destroyed during the year, of which skins or scalps were actually obtained, was 40,254; the number of gray wolves, 71; and the number of red wolves, 1,339. In addition, it is estimated that 54,000 coyotes not recovered were destroyed by the use of poisons. Because of unusually deep snows and stormy weather during the fur season in many districts of the West, the percentage of pelts recovered this year was lower than usual.

MOUNTAIN LIONS

The Biological Survey and cooperative hunters disposed of 252 mountain lions during the year—28 in Utah, 9 in Oregon, 10 in Montana, 36 in New Mexico, 152 in Arizona, and 17 in other States. In Arizona the total number of mountain lions destroyed in 13 years totals 1,062.

BEARS

It became necessary in the course of the year to destroy 280 bears that had acquired the habit of preying upon livestock. Bears are not as a rule of predatory habits, but individuals that become stock killers must be destroyed. The policy of the Biological Survey is to establish the fact that an individual bear has become addicted to stock-killing before authorizing its capture. During the year it was ascertained that certain bears had become predatory in communities in Arizona, Colorado, Montana, Oregon, Washington, and Wyoming. Urgent requests also came from West Virginia for assistance in controlling bears known to be killing livestock, particularly sheep.

BOBCATS AND CANADA LYNXES

Bobcats and Canada lynxes are the cause of considerable loss in livestock, especially sheep, during the lambing season. They are destructive also to game birds and have been known to kill the young of big-game animals. During the year 5,419 bobcats and 46 Canada lynxes were taken in the States in which predatory-animal control operations were conducted. The destructiveness of bobcats to game in the Eastern States has been called to attention during the past few years, and the bureau has had numerous requests for assistance in controlling these animals from New Hampshire, Virginia, West Virginia, and elsewhere.

HOUSE CATS

House cats are frequently abandoned and their offspring forced to gain a precarious living, and under such conditions, reverting to wild habits, they become skilled hunters and thus are a most serious menace to valuable birds, rabbits, and other small beneficial forms of wild life as well as to poultry. Where stray cats are numerous in city, town, or rural communities they are often the most

common of the carnivorous animals, and it therefore becomes necessary to control them. To answer the many requests for directions on trapping stray animals, a manuscript entitled "How to Make a Cat Trap" was prepared for publication as a leaflet (No. 50) and was in press at the close of the year.

CONTROL OF INJURIOUS RODENTS

Injurious rodents are the cause of enormous losses in farm crops and range forage in the United States, and their denudation of lands through close cropping of native grasses is one of the primary causes of destructive erosion. Control of these pests is one of the most tangible means of increasing profits in agriculture, horticulture, stock raising, and forestry. Control is necessary over the entire United States, and requires not only action by Federal and State officials but voluntary cooperation of hundreds of thousands of farmers and others. The fact has been recognized for many years that cooperation and systematic effort on all infested areas are essential.

The Biological Survey, with the responsibility of leadership in rodent control, has enlisted the cooperation of many thousands of farmers and other landowners. This has resulted in the destruction of certain rodent pests on millions of acres of valuable agricultural land and has been attended by an enormous direct saving and by increased production of important crops.

The eagerness with which more than 99,000 farmers during the year availed themselves of the opportunity to obtain relief from these pests through cooperative action is most significant and gratifying. Farmers are coming more and more to realize that losses from rodent pests need not be tolerated.

Though the progress in controlling rodents on range and farm lands is gratifying, a serious infestation on Federal lands, particularly on national forests, should have immediate attention. The carrying capacity of grazing areas on rodent-infested national-forest lands, estimated at more than 8,000,000 acres, is reduced from 25 to 80 per cent by such rodents as prairie dogs and ground squirrels. Federal lands are frequently centers of infestation, and if rodents are not controlled there permanent relief on adjacent private property is impossible. The Federal Government has a moral obligation to take care of its own lands, and a comprehensive rodent-control program, more extensive than present funds permit, is called for.

Organized rodent-control operations were carried on during the year under the leadership of the Biological Survey in 27 States, and educational work in five others. While these operations were largely conducted in the Western States, the East was not neglected, and it is planned to carry on more extensive work east of the Mississippi River when resources become available. Arrangements were made for undertaking rodent control in Mississippi, Alabama, and Louisiana, beginning July 1, 1929.

In field operations 3,718,000 pounds of poisoned bait, 106,000 pounds of calcium cyanide, and 411,000 pounds of carbon disulphide were used in controlling the rodent pests on 19,425,000 acres of land. Of the strychnine used in preparing bait, 75,600 ounces were purchased through the bureau from the manufacturers at a saving to cooperators of approximately $40,000. This saving allowed more extensive use of the cooperators' available funds. Data compiled at the close of the year show that since the inception of this work by the bureau, rodent pests have been eradicated on 14,300,718 acres of land, or brought under control there to such an extent that no damage from them was sustained.

During the year the operation of a central bait-mixing station in the Idaho district demonstrated its usefulness. This station has made it possible for cooperators to obtain satisfactory bait uniformly mixed and available at all times in adequate quantities at the lowest possible cost. During the year 436,000 pounds of oats were specially processed by steam rolling, 170,000 pounds of which were used in the Idaho district and 266,000 pounds in other States. A good quality of bait has thus been made available for poisoning ground squirrels, prairie dogs, and field mice and a substantial saving effected both to cooperators and to the bureau in time and reduced cost of materials.

GROUND SQUIRRELS

Campaigns to control the depredations of ground squirrels were carried on in all States west of the Great Plains and in Kansas and South Dakota. In most cases losses in agricultural crops were thus kept at a minimum. In the Fremont National Forest in Oregon a heavy ground-squirrel infestation, together with a

serious drought, threatened complete loss of forage for livestock in that section. This was obviated by the control of the ground squirrels in operations conducted under the leadership of the bureau.

Prevalence of bubonic plague among ground squirrels in parts of California led to an emergency appropriation of $100,000 by the State of California for the destruction of rodents on plague areas, and to urgent requests that the Biological Survey take care of the Federal lands involved. The resources of the bureau would not permit treating all Federal lands in these areas, but every assistance possible was given in the way of organizing the work and making available to cooperators information on efficient methods of control.

PRAIRIE DOGS

Since the bureau began the control operations against prairie dogs a total of 10,553,618 acres have been cleared of these rodents, and enormous saving to the livestock and farming industries and the checking of soil erosion over large areas have resulted. In a 5-year program for the eradication of prairie dogs in Kansas approximately 150,000 acres of land have been reclaimed for stock raising. On the basis of an average grazing requirement of 7½ acres a head, the reclamation of this acreage of prairie-dog-infested land would make available additional forage sufficient to support 20,000 cattle annually. Similar conclusions may be drawn relative to areas cleared of prairie dogs in other States.

JACK RABBITS

Preliminary experiments conducted by the Biological Survey in Arizona have demonstrated that 12 jack rabbits will eat as much green forage as a 120-pound ewe sheep, and that 59 will eat as much as a 750-pound cow; in the consumption of dry feed (alfalfa hay), 14 will eat as much as a sheep and 71 as much as a cow. The control of jack rabbits in all the territory west of the Mississippi River is thus of great economic importance. These animals are responsible for a considerable loss in farm crops, particularly alfalfa, range grasses, and fruit trees. They also destroy cotton plants in the Southwest, and in the Northwest ruin large quantities of hay in stacks during the winter. Operations for their control conducted in 13 States during the year resulted in the protection of large crop and forage areas.

The assistance rendered by field men of the Biological Survey in finding a market for wild-rabbit skins, and in giving instructions as to their preparation for shipment, has not only been responsible to a large extent for a profitable return on efforts expended, but has added impetus to control operations. During the year more than 8,000,000 jack-rabbit skins were thus sold, at prices ranging from 15 to 45 cents each, bringing approximately $2,000,000 to cooperators in Arizona, Colorado, Idaho, Kansas, Montana, Oregon, South Dakota, Utah, Washington, and Wyoming. If the market for jack-rabbit skins continues to yield profitable returns, the problem of controlling the animals will be greatly simplified. An exhibit illustrating the various steps in manufacturing felt hats from the fur of wild rabbits and showing the value of the skins has been prepared to stimulate control efforts.

POCKET GOPHERS

Cooperative campaigns for the control of pocket gophers, carried on in 14 States, afforded protection to large areas of forage and grain crops and to fruit and forest trees, as well as to irrigation water. A 2-reel motion picture film, Million Dollar Pockets, graphically depicting methods of controlling pocket gophers, was used to advantage during the year in practically every State in which the bureau is conducting control operations. The film has stimulated much interest and is accomplishing results by bringing before the public the necessity of controlling pocket gophers.

The establishment of airports is presenting an additional problem in the control of pocket gophers. The burrows and mounds constructed by these rodents on landing fields are a serious hazard. During the year the bureau has received many requests from airport officials for assistance in the control of pocket gophers, and where possible these hazards have been removed.

Pocket gophers not only eat growing grain but cover much of it with soil. Their mounds prevent close mowing and interfere with and break the machinery. Their burrows in irrigation ditches and canals often result in costly breaks, wasting water and interfering with its distribution. In irrigated sections the animals also cause considerable soil erosion by digging burrows through which the irrigation water escapes and carries away the soil. In addition, they kill trees

in orchards and in forest plantings by gnawing off the roots. A manuscript for a technical bulletin, The Pocket Gopher and Its Relation to Man, was prepared during the year.

FIELD AND HOUSE MICE

Although in some years both house mice and several forms of field mice are scarce locally in the United States, in other years they increase to large numbers and inflict heavy damage to farm and orchard crops. A serious infestation of white-footed field mice occurred during the year in five counties of South Dakota. In these counties the bureau carried on cooperative campaigns in which more than 21,000 pounds of poisoned bait were used, resulting in the protection of 53,380 acres of crops, mostly corn. The corn thus protected yielded an average of 12½ bushels to the acre, with a market value of 40 cents a bushel. Areas on which operations were conducted were not seriously damaged by field mice, while on the comparatively few unprotected areas there was practically a complete loss. The saving in the corn crop alone as a result of this work amounted to about $250,000, and this was effected through the expenditure of less than 1 per cent of that sum. Compaigns for the control of field mice were also conducted in Arizona, Idaho, Oregon, Utah, and Washington, and, mainly for protection of orchards, in seven Eastern States. A report on the Buena Vista Lake mouse infestation of 1926–27, prepared in this bureau, was published by the California Department of Agriculture in October.

BROWN RATS

The brown rat constitutes a greater economic menace, both in spreading disease and in destroying property, than any other single mammal pest. Rat control in cities as well as on farms has been stressed through publicity in connection with organized antirat campaigns undertaken in 17 States, 60 being conducted in the East alone. The best methods of controlling rats in the Eastern States were brought to the attention of the public through demonstrations, lectures, and exhibits; in 307 demonstrations there was a total attendance of 7,606, and a comprehensive rat exhibit, shown at 22 different points, had a total attendance of 159,350. In addition, about 120,000 copies of Farmers' Bulletin No. 1533, Rat Control, were distributed throughout the United States during the year, and a motion picture, How to Get Rid of Rats, which was made under the auspices of the bureau, was shown in practically every district of the United States where rats are a menace. This has proved to be one of the most popular films released by the department.

WOODCHUCKS

Woodchucks become serious pests when they come in contact with agricultural crops and orchards. In the East they appear to be more numerous in cultivated fields than formerly. In control measures undertaken in four States calcium cyanide as a fumigant and also poisoned baits were used. Leaflet No. 21, Woodchuck Control in the Eastern States, has been widely distributed, and a motion picture, entitled "The Eastern Woodchuck and Its Control," was filmed during the year in cooperation with the Office of Motion Pictures of the department. This film will soon be ready for release and will be of material assistance in disseminating information on measures of control.

PORCUPINES

On one national forest in Colorado some 200,000 acres are so badly infested with porcupines that these rodents are alleged to be more destructive to the trees, including young plantings, than is any other single agency, fire not excepted. Similar conditions have been reported from Arizona, California, Idaho, New Mexico, Oregon, South Dakota, Utah, and Washington. During the past two years a simple but effective method of poisoning porcupines has been worked out by the rodent-control experts in the Western States. Extensive operations are needed over many of our national-forest lands. A manuscript, The Control of Porcupines in the Western States, has been prepared for publication as a leaflet.

SOIL EROSION CAUSED BY RODENTS

The subject of soil erosion is not adequately treated unless consideration is given to the influence of close cropping of grazing areas and burrowing by rodents. Prairie dogs, ground squirrels, and several other rodents prefer to live in the richer valleys and bench lands, and in obtaining their food in such places they often destroy the grass roots and denude the lands of vegetative cover, converting them into barren wastes and subjecting them to permanent damage by erosion. Many areas in the West that formerly supplied excellent forage for livestock have thus been rendered useless. The burrows of pocket gophers, woodchucks, and other rodents admit surface water and aid in washing deep gullies on sloping lands, thus per-

manently injuring them for agricultural purposes. Adequate operations for the control of injurious rodents materially decrease the extent of soil erosion.

ACQUISITION OF LANDS FOR REFUGES

MIGRATORY-BIRD REFUGES

On February 18, 1929, the President signed the Norbeck-Andresen Migratory Bird Conservation Act (45 Stat. 1222). This act may properly be considered one of the most important wild-life conservation measures that have ever been written upon the statute books of the Nation.

The new law is designed to supplement and give additional force and effect to the migratory bird treaty act of 1918, by providing Federal funds for the appraisal, purchase, and establishment of large areas throughout the entire country to be maintained as inviolate sanctuaries—feeding, nesting, and resting grounds—where migratory game birds may enjoy complete protection. The areas to be established will also serve as sanctuaries for hundreds of other varieties of wild life, including both game and nongame species.

From year to year there has been a constantly decreasing acreage of water and marsh area in this country, aggregating many thousands of square miles. In recent years it has become evident that close seasons, bag limits, and restrictions imposed upon the gunners will prove ineffectual unless suitable habitat of wild fowl is preserved. The passage of the new conservation measure is a national recognition of the great importance of the birds of North America as a food supply, as an incentive to healthful sport, outdoor study, and recreation, and as aids in the development of agriculture.

As authorized by the act, an appropriat on of $75,000 was made available on July 1, 1929, for use in preliminary examinations and $5,000 additional for the expenses of the Migratory Bird Conservation Commission created by the act. In the following fiscal year (1931) the amount authorized to be appropriated is $200,000, and in 1932, $600,000, for surveys and the acquisition of lands for refuges. For the seven years following 1932 annual appropriations of $1,000,000 are authorized. At the close of this 10-year period it is anticipated that sufficient areas will have been procured to care for the more pressing and essential needs of the birds. Annual appropriations of $200,000 thereafter are authorized to pay the costs of maintaining the established refuges and patrolling them to protect the birds from poachers and predatory creatures, to control disease when pos sible, and to encourage the production of natural foods. It is contemplated that refuges will be established in suitable areas in every State of the Union. The key positions of the great system will closely follow the main migratory flight lines and concentrat on areas.

The approval of the Migratory Bird Conservation Commission must be had before any land purchase or lease may be consummated. The commission is composed of the Secretary of Agriculture, as chairman, the Secretary of Commerce, the Secretary of the Interior, two Members of the Senate, and two Members of the House of Representatives. To insure fullest cooperation with State governments, the ranking officer of the State game department, or in the absence of such department the governor or his representative, w ll serve as a member of the commission when areas proposed for refuge sites within his State are being considered.

Specific provision is made in the law that refuge areas may not be acquired in any State until that State shall have consented by law to the acquisition by the Federal Government of lands within the State. At the close of the year authority had been provided by special State legislation for the Federal Government to acquire lands for migratory-bird refuges in nine States—Kansas, Montana, South Dakota, North Carolina, New York, Missouri, California, Florida, and Illinois. In the following 17 States legislation already existing is considered to be sufficient to authorize the Federal Government to acquire refuge lands without further action of the legislatures: Arizona, Colorado, Connecticut, Georgia, Iowa, Louisiana, Maine, Maryland, Michigan, Minnesota, Nevada, New Mexico, Ohio, Oklahoma, South Carolina, West Virginia, and Wyoming.

It is necessary to ascertain, by examination, which of the numerous potential areas are biologically best adapted for refuges. Careful appraisals also must be made to determine the value of those tracts under consideration for purchase. Acceptances by the Secretary of Agriculture of gifts of land for refuge purposes are also authorized. The tasks of conducting the necessary biological investigations and of making the land-valuation surveys devolve upon the Bureau of Biological

Survey. A leaflet of preliminary information regarding procedure to be taken by persons having lands considered suitable and proposed for migratory-bird refuges (Bi–1018) was issued soon after the passage of the act.

This legislation and the program thereunder will put the United States in a position comparable with that already attained by Canada. That this action by the United States is considered equally beneficial to that country is evidenced by the following statement of Charles Stewart, Minister of the Interior, whose department is charged with the administration of legislation in Canada under the migratory bird treaty:

> Agricultural expansion and other developments in the southern United States, where most of Canada's waterfowl spend the winter, have gradually been encroaching upon the marsh lands there, and those interested in wild-life conservation in the United States have been trying for some years to find an adequate solution of the problem of providing these birds with suitable wintering marshes. Apparently the passage of the Norbeck-Andresen bill by Congress is the answer that has been sought. If the waterfowl are denied suitable wintering marshes they will become extinct in spite of all that Canada can do to protect them in summer, for birds go south in winter. Sportsmen and bird lovers of Canada will be delighted that this action has been taken under the migratory bird treaty by Congress, and that this bill provides for a series of inviolable bird sanctuaries in the South.
>
> With reference to the Dominion's action in this matter, I am happy to be able to say that Canada has reserved forty bird sanctuaries under the treaty, and in these the summer homes of seabirds on the coasts and of ducks and geese in the interior are protected. In addition to these sanctuaries 51 public shooting grounds have been set aside. These are great marshes where waterfowl nest safely during the breeding time, and which differ only from total sanctuaries in that shooting is allowed on them for a set time each fall.

UPPER MISSISSIPPI RIVER REFUGE LANDS

On the Upper Mississippi River Wild Life and Fish Refuge, a total of 87,900 acres of land had been taken under control up to June 30, 1929. In addition, there are 9,770 acres of State and city-owned lands adjoining that which is Government-owned. This acreage, together with the interlocking water areas, constitutes a total of approximately 156,000 acres of land and water now used for wild-life purposes on this refuge. Negotiations for the acquisition of the remaining land needed, constituting about 50,000 acres, are progressing as rapidly as conditions permit.

BEAR RIVER REFUGE LANDS

On the Bear River Migratory Bird Refuge in Utah, 15,860 acres of land were contracted for during the year, and under an act of Congress authorizing the exchange of lands contractual obligations have been entered into that will practically complete all land-acquisition negotiations on this refuge that are necessary. The fiscal year 1929 saw the completion of the engineering study designed to effect improvements required on the Bear River Refuge, such as dikes, ditches, and river-control works, and bids have been solicited for their construction.

MAINTENANCE OF WILD-LIFE RESERVATIONS

The year has brought a notable increase of public support for the refuge system as a means of restoring wild life in depleted areas. Refuges established on Federal lands and the development of the game-sanctuary idea in many of the States are strong indications that this method is becoming a prominent factor in wild-life administration. The mere acquisition of lands and their designation as wild-life sanctuaries, however, are not in themselves sufficient to obtain the results desired. In most instances where the sanctuary method has failed to fulfill expectations the cause will be found to be an absence of sound administrative plans or inadequate maintenance funds.

Without proper administration, many of the sanctuary areas have no more value as wild-life refuges than have adjacent unprotected lands. Under most conditions the successful administration of a refuge requires constant supervision. Game and food species must be protected against encroachment by poachers and often against such destroyers as forest fires. There are likely to be periods during which some predatory forms must be controlled. On the other hand, overabundance of the species to be protected may become a serious menace to their welfare, and arrangements must then be made to dispose satisfactorily of the surplus. On areas set aside as big-game preserves such surpluses result in overgrazing. Death from starvation and permanent injury to the range may be expected where overgrazing becomes serious.

NEEDS OF RESERVATIONS

As in former years appropriations for improvements on wild-life reservations maintained by the Biological Survey have covered only the most pressing necessities; additional funds are needed for proper maintenance. Full-time protectors are in charge of the big-game preserves, the Upper Mis-

sissippi River Wild Life and Fish Refuge, and a few of the more important bird refuges; some of the bird refuges also are policed at critical periods of the year by part-time protectors, but on others practically no protection has been possible with the funds available. It is imperative that more adequate policing and the necessary equipment for the purpose be provided for a considerable number of these reservations. Some of the big-game reservations should be enlarged to permit carrying fair-sized herds of pure strains of buffalo and other species of big-game mammals not yet properly provided for.

NEW RESERVATIONS

Three new reservations were established during the year: Nunivak Island in Bering Sea, off the coast of Alaska, set aside primarily for a reindeer experimental tract; Fort Keogh, Mont., embracing the 57,000-acre United States Range Livestock Experiment Station administered by the Bureau of Animal Industry, on which both waterfowl and upland birds will find suitable habitat and protection; and Tule Lake, Calif., a sump of 10,300 acres within the Klamath irrigation project, which serves as a retreat for waterfowl and shore birds and offsets to some extent the loss of sanctuary caused by the drying up of the lower Klamath refuge. An area of 2,800 acres in the southern portion is open to hunting during the shooting season, and the remaining 7,500 acres are reserved for strictly sanctuary purposes. Preliminary steps also have been taken for the establishment of a bird refuge on Cedar Keys, off the west coast of Florida; and under authorization of Executive order of June 20 preliminary plans were made for establishing an antelope range in Nevada in cooperation with the National Association of Audubon Societies.

BIG-GAME PRESERVES

The following big-game preserves are maintained by the Bureau of Biological Survey in the Western States: The National Bison Range in Montana; the Niobrara Reservation in Nebraska; the Sullys Hill Game Preserve in North Dakota; the Wind Cave Game Preserve in South Dakota; and the Winter Elk Refuge in Wyoming. The numbers of buffalo, elk, antelope, mountain sheep, and white-tailed and mule deer on the four fenced preserves (not including the Elk Refuge), and the increases in the herds, are shown in Tables 1 and 2.

TABLE 1.—*Big-game animals on reservations of the Bureau of Biological Survey, June 30, 1929*

Preserve	Buffalo	Elk	Antelope	Mountain sheep	Deer		Total
					White-tailed	Mule	
National Bison Range, Mont.	367	60	----	100	[1] 32	[1] 139	698
Wind Cave Game Preserve, S. Dak.	174	[1] 98	25	----	----	----	297
Sullys Hill Game Preserve, N. Dak.	13	31	17	----	1	----	62
Niobrara Reservation, Nebr.	106	[1] 115	9	----	1	----	231
Total	660	304	51	100	34	139	1,288

[1] Estimated.

TABLE 2.—*Young of big game born on reservations of the Bureau of Biological Survey during the calendar year 1928*

Preserve	Buffalo	Elk [1]	Antelope	Mountain sheep	Deer [1]
National Bison Range, Mont.	78	----	----	24	----
Wind Cave Game Preserve, S. Dak.	41	----	7	----	----
Sullys Hill Game Preserve, N. Dak.	4	----	----	----	----
Niobrara Reservation, Nebr.	12	----	3	----	----
Total	135	----	10	24	----

[1] In the case of elk and deer it has thus far been impracticable to furnish definite figures regarding the young born.

NATIONAL BISON RANGE

Disposal of surplus animals on the National Bison Range, Mont., during the past winter became necessary as an emergency measure. To prevent excessive overgrazing, 427 elk, 151 buffalo, and 16 mule deer were removed. Of the elk, 213 were given to the State of Montana for stocking purposes; 49 were disposed of to private individuals, also for stocking or propagation; and 165 that could not be otherwise used were slaughtered for meat, chiefly for Indians on a near-by reservation. Of the 151 buffalo disposed of during the year, 4 were sent as gifts to various States; 5 were sold alive; and 142, for which there was no demand for propagating purposes, were butchered. The 16 mule deer were shipped alive from the range for sale, 10 to California and 6 to Texas. With a reduced number of animals on the limited range, the vegetation should now make good recovery and restore normal grazing conditions. The herd of mountain sheep maintained at the bison range has made a most satisfactory increase, and it is estimated that there are now about 100 of these animals on the reservation.

NIOBRARA RESERVATION

Lack of facilities makes it difficult to handle the surplus animals on the Niobrara Reservation in Nebraska. During the year, however, 4 buffalo and 9 elk were disposed of as dressed carcasses, and 3 elk were prepared as specimens for the National Museum at Stockholm, Sweden. Four antelope were born this spring and are in good condition, though there is a net loss in the band, as 7 died during the year, 3 of which were killed by bobcats.

The experiment in raising wild turkeys has not been wholly satisfactory. The natural conditions afforded on this range are favorable to their breeding and rearing the young, but because of their roving nature it is impossible to keep them within bounds, and consequently some are killed.

Heavy rains on the reservation resulted in a good crop of hay, of which 40 tons were shipped for use at Wind Cave Game Preserve.

WIND CAVE GAME PRESERVE

By completion of a big-game fence at the Wind Cave Game Preserve, S. Dak., the extent of the refuge was nearly doubled and a new pasture provided into which 77 buffalo were turned in May. The two big-game pastures now maintained are on opposite sides of the highway that passes through the National Park and Game Preserve, and the big-game animals may now be seen by passers-by. Negotiations were concluded during the year for an adequate supply of pure water for domestic and stock purposes.

The serious shortage of range forage last winter made it necessary to feed the big-game animals beginning on February 6. Approximately 42 tons of hay were purchased locally, and 40 tons were obtained from a surplus on the Niobrara Reservation, Nebr. Surplus stock disposed of during the year included 41 buffalo and 65 elk.

The dam across Cold Springs Creek, authorized by Congress, designed to impound water on the game preserve, was in process of construction before the end of the fiscal year and should be completed in the summer of 1929. Arrangements have been made to permit the State of South Dakota to widen the dam sufficiently to serve as a main highway connecting Hot Springs, the Wind Cave Park, the Wind Cave Game Preserve, and the Custer State Park and Game Preserve.

SULLYS HILL GAME PRESERVE

In order to restrict the herds of big game to the carrying capacity of the Sullys Hill Game Preserve, N. Dak., 7 buffalo and 10 elk were disposed of during the year. Progress was made in the establishment of an exhibition pasture, in which it will be possible to retain animals where they can be more readily seen by visitors. This reservation has become one of the favorite resorts for tourists and others interested in wild-life conservation, and during the year it was visited by 22,674 persons. Eight antelope were born in the spring, and all are in satisfactory condition. Improvements much needed in the water system supplying the headquarters and the public picnic grounds were nearly completed.

ELK REFUGE

About 6,000 elk of the southern Yellowstone herd were fed on the Elk Refuge, in Jackson Hole, Wyo., between February 5 and April 1. The winter was mild, and as the heavy snows of January and the first week of February melted early in March, the elk were able to forage on bare patches on the range. On a ranch 7 miles from Jackson, which was used by the State of Wyoming as a feeding

ground, about 300 elk were cared for, and nearly 300 tons of hay were left there after the feeding. The 195 tons of hay remaining on the Izaak Walton League addition to the refuge at the close of the previous feeding season were disposed of to the State at the first of the year. Later, 1,266 tons were harvested on the refuge, and this, augmented by 370 tons purchased by the State, was available for winter feeding. About 920 tons were used in the 56-day feeding period, leaving a surplus of 716 tons on refuge lands. The State has on hand approximately 450 tons, making a total of 1,166 tons on hand on June 30.

New farming equipment was obtained during the year, and this, together with additional labor, has made it possible to increase the hay acreage on the refuge, improve the stand, and decrease the quantity of squirreltail grass, which has been found to be injurious to the elk. With the new equipment the acreage cost of operations has been considerably reduced. To be prepared to care for an optimum herd of 20,000 elk, additional lands should be acquired for hay and pasture and to allow the animals easy access to the main refuge.

BIRD REFUGES

Eighty-two bird refuges are administered by the Biological Survey in the United States, Alaska, Hawaii, and Porto Rico, including the five big-game preserves, on which birds also are protected. A list of these and other national wild-life reservations (Miscellaneous Publication No. 51) was in press at the close of the year, and an article on the indispensable part that bird refuges play in saving wild life was published in the Yearbook of Agriculture, 1928, of the department. No adverse conditions have been reported on any of the refuges, and only a few require detailed comment.

BEAR RIVER MIGRATORY-BIRD REFUGE

Much of the preliminary work on the Bear River Migratory-Bird Refuge in Utah has been completed. It has been necessary to move slowly in the establishment of this great refuge, and considerable time, thought, and effort have been required to solve problems relating to land transfer and acquisition, surveys, and engineering work. The State legislature of Utah passed an additional enabling act early in the year to facilitate the establishment of the refuge, in which the Biological Survey has received the hearty cooperation of State officials, sportsmen, and others.

Migratory-waterfowl conditions on the refuge were satisfactory, and little duck sickness was in evidence at the close of the fiscal year. Many migratory birds nested on the refuge during the spring.

The completion of engineering construction will impound large bodies of pure, fresh water, and it is confidently expected that this additional supply will practically eliminate the danger of such large losses of wild fowl as have occurred on these marshes in the past.

SAVANNAH RIVER BIRD REFUGE

The Savannah River Bird Refuge, in South Carolina, is one of the most accessible of the bird reservations maintained by the bureau. A State highway traverses it, and passing tourists in great numbers are able to see the birds feeding in the marshes or flying over and across the sanctuary. Most of the area of this refuge is attractive to marsh-frequenting birds, and some young timber along the northern boundary should eventually furnish an excellent breeding place for the wood ducks of the region. The refuge has recently been posted with signs large enough to be seen from the road, advising the public of its character as a Federal bird refuge and that the birds are protected at all times. The available funds do not permit employing a reservation protector throughout the year, but patrol service has been maintained in seasons when the birds are present in greatest numbers.

LAKE MALHEUR BIRD REFUGE

The water supply at the Lake Malheur Bird Refuge, in Oregon, was more abundant during the summer of 1928 than in many recent years, but still far from adequate. The question of ownership of lands in the lake bed and its immediate vicinity continues to be a serious obstacle to the development of the refuge. Two bills were introduced in the last session of Congress to permit the State of Oregon and private individuals to sue the Federal Government to determine ownership and quiet title, one of which was passed by the House but failed in the Senate. It is hoped that legislation of this character may be passed at an early date.

ALEUTIAN ISLANDS RESERVATION

By Executive order of November 23, 1928, seven islands—Akun, Akutan, Sanak, Tigalda, Umnak, and Unalaska, including Sedanka—were withdrawn from the Aleutian Islands Reservation, Alaska, and restored to the public domain to be subject to the general land laws, because of their greater value for stock-raising than for wild-life purposes. The remainder of the reservation was supervised to the extent that the facilities permitted by the Alaska Game Commission in cooperation with the Biological Survey.

HAWAIIAN ISLANDS RESERVATION

The widely scattered units of the Hawaiian Islands Reservation present a difficult problem of patrol. The importance of keeping this extended sanctuary inviolate must be emphasized, as many rare birds frequent the islands, and some of the breeding colonies are subject to raiding by plume hunters. In the past the reservation has suffered seriously at times from the organized work of such poachers. Means should be provided to allow regular supervision of these islands. To do this effectively a patrol boat for the use of a resident protector is required.

The discovery of pearl-shell oysters at Pearl and Hermes Reef within the Hawaiian Islands Reservation was followed by the receipt of applications from several Hawaiian concerns for permits to carry on shell and other fishery operations there. In view of the bureau's lack of facilities for investigating conditions on the reservation or for supervising commercial activities there, a general order prepared in the Biological Survey was approved by the Secretary authorizing the governor of the Territory for the present to issue permits for the use and occupancy of the reef for these purposes.

UPPER MISSISSIPPI RIVER WILD-LIFE REFUGE

Increased attention has been given to the protection of the wild life of the Upper Mississippi River Wild Life and Fish Refuge, the area of which is being constantly increased. Beavers obtained in northern Wisconsin and Minnesota and released on the refuge are apparently doing well.

The experimental waterfowl colony maintained on Lake Winona, Minn., continues to develop with gratifying results. A considerable tract of marsh and shore along the lake, which was fenced by the city of Winona, makes it possible more adequately to protect the wild life therein. Approximately 500 ducks were hatched in this area during the spring. Half of these will be banded and released prior to the southern migration this fall, and their return next spring to nest on the refuge will be looked for.

There has been a decided surplus of muskrats on the refuge, and trapping under regulation has been permitted in a manner that appears to have been satisfactory both to the trappers and to the general public. Approximately 30,000 muskrats were taken and brought an average price of $2 each, the refuge thereby producing a revenue to the local public of about $60,000.

Pollution of the waters in the vicinity of the refuge has come from both city waste and the discharge from oil burners and tankers. This condition should be remedied. No serious fires occurred on the refuge during the year, as several that were started were immediately brought under control by prompt action on the part of the reservation rangers. The fire hazard in dry years, however, is serious.

RECREATIONAL USES OF WILD-LIFE REFUGES

Although wild-life reservations are established primarily for the preservation of the birds, mammals, and other native species, their existence in some instances is still further justified by the recreational opportunities they provide for the public. It is believed that this feature deserves development to the greatest extent possible consistent with the use of these areas as refuges for wild life. Each year increasing numbers of the American public visit the big-game preserves and certain of the bird refuges. The visitors compose all classes, from the student of wild life to those who have merely a casual interest. Facilities at these reservations are not yet sufficient to allow the public to enjoy them to the fullest extent possible. It is desirable that the big-game preserves be provided with roads, water, sanitary facilities, and other conveniences, and that, when necessary, guards and other personnel be employed to guide and control the movements of the visitors in order that they may observe the wild life under natural conditions without molesting it or being in danger themselves. These desirable results can be attained only by a series of improvements undertaken over a period of years.

ADMINISTRATION OF WILD-LIFE PROTECTIVE LAWS

Unquestionably the respect for Federal, State, and Territorial laws designed to afford protection to wild life is increasing. Though a larger number of cases was reported for prosecution in the courts during the fiscal year just closed and more jail sentences were imposed than in the previous year, this fact does not necessarily indicate actual increase in the number of persons wilfully violating the regulations. It may be taken to indicate, however, that public interest in the enforcement of laws for wild-life conservation generally is increasing and that, as a result, a greater mass of evidence is being placed in the hands of enforcement authorities, particularly as conservationists, sportsmen, and trappers are all interested in obtaining maximum returns from the administration of laws protecting big game, game birds, and fur bearers.

PROTECTION OF MIGRATORY BIRDS

Illicit operations by the market gunner, the spring shooter, and the night hunter are still conducted on a serious scale in some localities, but every effort commensurate with ability of a limited enforcement personnel is being made to curb these violations. That attempts to enforce the provisions of the migratory bird treaty act with only 23 full-time United States game protectors can not be wholly effective is obvious. The problem is becoming more serious as wilful violators become aware of the lack of an adequate force of protectors.

The United States game protectors form an important contact between the Bureau of Biological Survey and the general public, and they have manifold duties in this relationship outside the actual patrol work. They are called upon constantly to supply reliable information and advice pertaining to wild life and its conservation. They are at times required to make investigations of a semiscientific nature. They also are invited to attend gatherings of conservation organizations, and frequently appear upon the program. Their educational work has resulted in improved conditions and a better observance of the Federal law on the part of the younger generation. Such duties, while essential, are classed as secondary and are not permitted to interfere with the regular law-enforcement program.

There has been an insistent demand during the past year from State game officials and organizations engaged in wild-life conservation, and from individual citizens as well, for an extension of the law-enforcement activities directed by the Biological Survey. At present each United States game protector on the average must have within his patrol district an area approximately equal to two States. It is contended that if these patrols could be increased so as to permit the employment of one protector in each State, with necessary assistants, the beneficial results accruing would be beyond all proportion to the comparatively small additional expense involved.

The suppression of illegal practices in the taking of migratory birds in the United States does not offer obstacles that are insurmountable. Those that are encountered can be met and overcome by the employment of an effective and energetic force of game protectors, supported by favorable public opinion.

ASSAULTS ON PROTECTORS

There is urgent need for a Federal statute under which assailants of Federal officers may be adequately punished. The occupation of a game protector is hazardous work, and lack of protection in the performance of his duties not only diminishes the effective execution of the police powers conferred but provokes contempt for the law. Since the passage of the migratory bird treaty act, one Federal game protector has been killed while engaged in the enforcement of the regulations, two have been seriously injured, and others have been assaulted by persons whom they were attempting to arrest. In cases of such assaults redress can be sought only in local courts, where the results have proved unsatisfactory.

AMENDMENTS TO REGULATIONS

After consideration by the Migratory Bird Treaty Act Advisory Board, amendments were adopted by the department and approved by the President relating to the manner of issuing scientific-collecting permits, and to records and reports required of taxidermists concerning the handling of migratory birds; prohibiting the hunting of migratory game birds from automobiles; and changing open seasons on certain species, including mourning doves in North Carolina, Georgia, Louisiana, and Alabama; waterfowl in Illinois, Massachusetts, Missouri, Oklahoma, and east of the

Cascade Mountains in Washington; and woodcock in all States in which its hunting is permitted. The close season was continued on greater and lesser yellowlegs.

Many requests have come to the Biological Survey to allow limited shooting of swans, the plea being made that these birds were destroying wildfowl food plants in such quantity as to menace the future supply for other waterfowl. Investigations, however, have failed to show that swans do this to any greater extent than do other species of waterfowl. Most careful consideration has been given the matter, since an error at this stage might very well result in the total extermination of rare and valuable species. The complete protection enjoyed by swans throughout this country has been continued for the reason that the total number of the trumpeter and whistling swans combined is not large and that irreparable damage would result if shooting were permitted, as the average gunner can not distinguish between the two species. A plea was made through the press for the sympathetic consideration of all sportsmen, "in view of the rather precarious condition of the whistling swan and the still more dubious situation of the trumpeter swan." Swans enjoy similar protection in Canada, under the terms of legislation protecting birds that migrate between the two countries.

LAW VIOLATIONS AND PENALTIES

The handling and disposition of cases of violation of the migratory bird treaty act during the year are shown in Table 3. Because of impositions of adequate fines in State courts, youthfulness of offenders, lack of sufficient evidence, or other satisfactory reasons, 78 cases reported by United States game protectors and United States deputy game wardens were not forwarded for prosecution. Federal judges imposed fines ranging from $1 to $500, aggregating $13,368.95, and jail sentences in 27 cases. Defendants were placed on 6-months' probation in two cases, and jail sentences of 6 months each were suspended in six others, as was one 60-day sentence. One defendant was sentenced to 10 days in jail, 18 to 30 days in jail, and 1 to 6 months. Plumage and migratory game birds of an estimated market value of $2,500 were confiscated. In the majority of instances the game birds seized were donated to hospitals and other charitable institutions for use as food, the plumage being utilized for scientific and educational purposes.

Since the passage of the Upper Mississippi River Wild Life and Fish Refuge act, 11 violations of that law have been reported for prosecution in Federal courts. The first two of these terminated in fines of $25 each, and the remainder are still pending. Reservation wardens apprehended 23 persons violating State game laws on the refuge, 16 in Minnesota, and 7 in Wisconsin. All these cases were terminated by fines, totaling $870. Three defendants who defaulted were required to serve jail sentences of 12, 60, and 90 days, respectively.

Under section 84 of the United States Criminal Code protecting wild animals, birds, and birds' eggs on Federal refuges, 9 new cases were reported for prosecution in Federal courts: of these, 2 were dismissed, 4 were closed by fines of $10 to $25 each, and the remainder are still pending.

PERMITS TO KILL INJURIOUS BIRDS

It had not been necessary for several years for the Secretary to issue an order to permit the killing of wild ducks to prevent serious injury to agriculture or other interests. This year, however, at the urgent request

TABLE 3.—*Cases of violation of the migratory bird treaty act handled during the fiscal year 1929, and disposed of or still pending*

Cases	Number	Disposition of cases	Number
Pending from former year	386	Convictions	399
New cases reported	576	Dismissals	39
		Verdicts of not guilty	11
Total	962	No bills found	9
		Nolle prosse	46
Disposed of	508	Death of accused	4
Pending at end of year	454		
		Total	508

of the Kansas State game and fish warden, and in order to prevent serious depredations to grain that had not been harvested, an order was signed by the Secretary on January 18 allowing landowners and their bona fide employees, when acting under permits countersigned by the State game authorities, to shoot wild ducks at any time. After the issuance of the order methods of control were adopted that proved successful in frightening the ducks from the fields. The grain was thus protected without the necessity of killing the birds, and no permits were actually issued under the order.

PERMITS ISSUED

To allow the possession of certain migratory birds for legitimate purposes during the close seasons, the migratory bird treaty act authorizes the issuance of permits for making collections for scientific purposes, including bird banding, for possession by taxidermists, for propagation, and for certain other purposes. During the year such permits were issued as follows: Scientific collecting, 204, making the total number outstanding, 1,789; scientific possession (taxidermists), 27, bringing the total to 335; special possession, 101, total 570; propagation (possession and sale) 638, total, 3,874; bird banding, 227, total, 1,552; taking for propagation, 101. Reports on operations under permits are required to be made each year, and when they are not forthcoming the permits are revoked or canceled. Permits surrendered for cancellation or revoked during the year numbered 591.

The reports filed show that during the year 47,772 waterfowl of species protected by the migratory bird treaty act were propagated in captivity. The greatest numbers were mallard ducks (42,727), wood ducks (551), and Canada geese (3,973). Others being propagated under permit in small numbers were pintails, teals, widgeons, gadwalls, shovelers, and brant. Stocks disposed of by propagators consisted of 16,987 ducks for food and 8,947 as breeding stock, and 379 geese for food and 3,060 for propagation.

INTERSTATE COMMERCE IN WILD BIRDS AND MAMMALS

Since the features of the Lacey Act of 1900, as amended in 1909, relating to the interstate transportation of wild birds were superseded by broader provisions of the migratory bird treaty act of 1918, the application of the Lacey Act has been limited to interstate traffic by common carrier in the dead bodies or parts thereof of wild animals killed within, or transported from, a State illegally. Thus shipments of carcasses of wild animals by parcel post, properly marked as to contents, and their transportation by private carriers are not prohibited. Each season's operations demonstrate more clearly the need of amendments to the Lacey Act to apply to interstate transportation in any manner, and of further amendments to confer upon Federal officers police powers to seize illegal shipments and return them to the State from which they originated or in which the violation occurred, or to dispose of them on behalf of the State.

No Federal prosecutions have been instituted during the fiscal year for violations of the Lacey Act, although the investigations and activities under its provisions probably have been more extensive than during any similar period for the past decade. Most of the investigations were concerned with the skins of fur-bearing animals. Violations of the Federal law are predicated upon infractions of State laws. Federal investigations of such cases frequently disclose that State laws have been violated, although the evidence is insufficient for instituting Federal prosecutions. Federal action is largely dependent upon the nature of a State's legislation governing export shipments, and the fact that in many cases a State's legislation is defective in some respects precludes Federal prosecution and thus deprives the fur animals of that State of much of the supplemental protection that otherwise would be afforded them under the Federal legislation.

Field employees of the Biological Survey have conducted extensive investigations at raw-fur centers, and the information discovered relating to 4,500 apparently illegal shipments was transmitted to the game officials of the States affected. Reports received during the year indicate that approximately 2,000 such cases were actually violations of State law, and of these, 500 were closed without prosecution, because of youth of the violators, misunderstanding of the laws, or various other reasons. In the 1,500 cases prosecuted in State courts, fines and costs aggregating $37,838.75 were imposed and in addition in 11 instances jail sentences ranging from 10 to 60 days (aggregating 275 days). Seized skins illegally taken netted $667.50 in one State and $210 in another. In three other States skins of 56 beavers,

135 muskrats, and 12 minks were confiscated.

FEDERAL AND STATE COOPERATION

State game officials have expressed their appreciation of the cooperation of the Bureau of Biological Survey in furnishing information concerning illegal interstate shipments of wild birds and mammals or other infractions of State wild-life legislation. This cooperation has contributed substantially to the upbuilding of a wholesome respect for game laws as well as materially increasing the amount of fines collected in State courts. Through a slight reorganization the bureau is in position to increase this line of cooperative work and to render the States even more effective service.

State game officials have continued their cooperation with United States game protectors in the enforcement of Federal wild-life legislation. Closer and more effective cooperation has been effected by the wide distribution of publications prepared by the Biological Survey. Among these were the twenty-ninth annual Directory of Officials and Organizations Concerned with the Protection of Birds and Game (Miscellaneous Publication No. 30); the annual game-law bulletin for 1928–29 (Farmers' Bulletin No. 1575) of which 350,000 copies were distributed; the annual fur-law bulletin (Farmers' Bulletin No. 1576) (100,000 copies); two pamphlets (S. R. A.—B. S. 70 and S. R. A.—B. S. 71) containing the text of the treaty between the United States and Great Britain for the protection of migratory birds, of the Lacey Act regulating interstate commerce in game, and of other Federal laws and regulations pertaining to the protection of wild life; and the annual poster (No. 47–Bi) showing the open seasons for hunting game throughout the United States, Canada, Alaska, Newfoundland, and Mexico. The poster is of special importance because it is published immediately after the adjournment of the State legislatures making changes in the open seasons and is generally the first available printed information relative to such changes. It is sent to postmasters and others in important wild-fowl States, and is not only thus placed conspicuously where all may obtain the information, but is republished in full by numerous outdoor and sportsmen's periodicals.

Statistics relative to hunting licenses issued by the various States for the season 1927–28 and compiled by the Biological Survey show that there were more than 6,450,000 licenses issued and that they returned to the States a revenue of more than $9,300,000, mostly for use in game-protection work. Similar data for the previous season were published in the 1928 Yearbook. These figures, for many States, cover combined hunting and fishing licenses.

IMPORTATIONS OF FOREIGN BIRDS AND MAMMALS

1929

The close of the fiscal year marks the completion of 29 years of regulation by the Bureau of Biological Survey of importations of birds and mammals from foreign countries, and the bureau is now entering the closing year in the third decade of governmental supervision of entries, an experiment conducted on a more extensive scale than has ever been attempted by any other country.

Nearly 10,000,000 birds and a large number of mammals have been imported since 1900, but so far as known during this time no injurious species not previously imported has obtained a foothold in the United States. The English sparrow and the European starling were already here; and the crested Chinese starling, which has gained a foothold in British Columbia, has not yet crossed the line. Some years ago Canada adopted restrictions modeled after the laws of the United States regulating the importation of foreign birds and mammals, and in some respects these restrictions are even more stringent than those in force in this country, so that the danger of entry of foreign species from the north has been largely removed. Importations from the south, particularly those coming through Mexico and Cuba, require vigilant supervision and may necessitate more effective regulation in the near future. The experiment in which the United States has been engaged has demonstrated the possibility of preventing the introduction of species injurious to agriculture, in spite of the great extent of the country's boundaries and the enormous increase in importations.

Notwithstanding the constant influx of foreign birds and mammals the United States has actually gained relatively few species. The Hungarian partridge has been successfully introduced and has become sufficiently acclimatized in several Western States to permit short open seasons for hunting in some sections. The Chinese

dove has become locally acclimatized at Los Angeles, Calif. The true Mongolian pheasant has been introduced in some numbers, and the supply of Old-World pheasants, formerly obtained from abroad, is now furnished chiefly from birds bred in this country, either on State or on private game farms. The supply of quail, formerly obtained from the Southwest, is now derived solely from the States of northeastern Mexico, and importations have increased to nearly 87,000 a season. The demand for aviary and cage birds has increased the importations to the point where these birds average nearly a thousand a day, but most cage birds except parrots are short-lived; some live only a few weeks, and the majority probably do not survive on the average more than three years.

The number of importation permits issued during the year was 1,254, an increase of 43 over that of the preceding year, and inspection of shipments at ports of entry increased from 441 to 510. In addition, 19 permits were issued at Honolulu, Hawaii, for the entry of 637 miscellaneous birds. The importation of birds was the largest since the issue of permits began. Of the total number brought in, more than two-thirds were cage birds, and more than half were canaries. Game birds included less than a third of the total number, and chiefly comprised Mexican quail and Hungarian partridges. Importations included 28,517 Hungarian partridges, 8,061 pheasants, a few waterfowl, and many miscellaneous birds. The total number of foreign birds imported was 825,486, of which 12,603 were without permit, being mainly brought in under declaration of passengers' baggage. The importations under permit consisted of 589,251 canaries, 57,098 parrots, 87,131 quail, and 79,403 representatives of miscellaneous species.

MAMMALS

Mammals imported under permit consisted chiefly of foxes, muskrats, and bears, with a number of other species intended largely for exhibition. Comparatively few fur-bearing animals except foxes and muskrats were brought in.

The number of foxes imported from Canada, which numbered 1,091, showed a marked decrease from the previous year, 3,044. Evidently fox farms in the United States are now supplying most of the breeding stock required.

During the summer and early fall there are frequent demands for permits to import black bears from Canada. Most of these bears are cubs brought in from the Provinces of Manitoba, Ontario, and Quebec, intended for exhibition in parks and zoological gardens. The entry of these animals indicates a regular market for young bears, notwithstanding that a number of surplus animals are distributed each year from certain of the national parks in the West. Applications are made for permits to import mountain lions, wolves, coyotes, and wild cats at points along the Mexican border, also evidently for exhibition purposes. Notwithstanding the number captured in campaigns against predatory animals, the present demand for exhibition stock apparently can be supplied more cheaply by importation than by the capture of animals in remote parts of the West.

Among the rare animals imported during the year was a Guadalupe Island fur seal (*Arctocephalus townsendi*) for exhibition in the San Diego, Calif., Zoological Park, the only specimen of its kind in the United States; two Siberian snow leopards (*Felis uncia*), and four gorillas. Two of the gorillas died within a few months after arrival, and the other two were placed on exhibition, one in the National Zoological Park, at Washington, and the other in the New York Zoological Park. Other rare species were brought in for zoological gardens and for traveling menageries.

GAME BIRDS

Mexican quail.—Preparations were made for the receipt of the largest number of quail ever brought in from Mexico, and concessions were granted by Mexican authorities to four exporters, three of whom operated as heretofore at the ports of Brownsville, Laredo, and Eagle Pass, Tex. The number of quail actually imported was 87,131, or about 2,000 more than in 1926, the year that previously held the record. Of these, 28,718 were entered at Brownsville, 45,000 at Laredo, and 13,413 at Eagle Pass, destined chiefly to Alabama, Kansas, Kentucky, Maryland, Oklahoma, Pennsylvania, Texas, and Virginia. The supervision of importations at the border was conducted through cooperation with the Bureau of Animal Industry, whose inspectors issued the permits, examined all entries before reshipment, and furnished weekly reports on the number of quail entered and details as to their destination. No quail disease was reported during the season.

Other game birds.—Much interest has been displayed during the past two or three years in the importation of Hungarian partridges. Since this species has been successfully established in several Western States, others have sought to obtain breeding stock to build up their game resources. New York has been particularly active in this respect, and during the year has received several large shipments. The supply of birds is obtained chiefly from Czechoslovakia and Hungary, and the demand has been so great as to cause apprehension as to the source of supply. Early in the year shipments from Czechoslovakia were suspended for a time because of the disastrous effect of the cold winter on the stock of native birds. In addition to exporting 90,000 to 100,000 dead partridges annually, Czechoslovakia exports a large part of the live birds entered in the United States, England, and Switzerland. Many of these birds are bred solely for the export trade, and the prices vary from $1.76 to $2.94 each, to which is added a 25 per cent ad valorem export fee. Several shipments of pheasants were imported from Europe, chiefly to introduce new blood into the stock in the United States. A limited number of grouse, chiefly ruffed and sharp-tailed grouse, were entered from Alberta, and nearly 500 diminutive button quail (*Excalfactoria lineata*) from the Philippines and Australia, and 40 tinamous (*Nothura maculosa*) from southern South America.

CAGE BIRDS

The continuing demand for birds for zoological gardens, aviaries, and the retail trade has developed in the United States probably the largest market for cage birds of any country in the world. Statistics for foreign countries are lacking, but in the United States evidence seems to show a continually increasing demand, already large in volume. Most of these birds are canaries raised in captivity, mainly in Germany, but a few come from the Orient, chiefly China and Japan; and next in importance are parrots. The variety of miscellaneous birds brought in is very great, and the demand for rare species for private aviaries and a few of the zoological gardens stimulates importers to search the most remote corners of the earth for desirable species. Some of the private collections now maintained in the United States are remarkable both in their size and variety and compare favorably with some of the larger public collections.

An unusual number of rare species were imported during the period covered by this report. One of the largest consignments was that obtained by the expedition sent to New Guinea by the New York Zoological Society, which brought back about 220 birds, including 9 kinds of birds of paradise, among which were 16 Lawes's 6-plumed birds of paradise (*Parotia lawesi*), 2 long-tailed birds of paradise (*Epimachus fastosus meyeri*), 1 Hunstein's bird of paradise (*Diphyllodes magnificus hunsteini*), and 3 horned manucodes (*Phonygammus keraudrenii jamesi*); there were also several rare pigeons, among which were 1 white-throated pigeon (*Columba vitiensis halmaheira*), 7 golden-headed fruit pigeons (*Sylphitreron ornatus gestroi*), 1 superb fruit pigeon (*Ptilinopus superbus superbus*), and 8 Stephanie's pigeons (*Chalcophaps stephani*). Among other notable arrivals of the year were a number of emperor starlings (*Cosmopsarus regius*) from Africa, 3 Fiji shining parrots (*Pyrrhulopsis splendens*), 7 Palawan peacocks (*Polyplectron nehrkorni*), 10 blue-crowned hanging parrakeets (*Tanygnathus luconensis*), 20 Kea parrots (*Nestor notabilis*), 2 Forsten's lories (*Lorius forstenii*), 2 black-tailed Australian parrakeets (*Polytelis melanura*), 7 Cassin's doves (*Leptotila cassini*), and a pair of red-breasted geese (*Branta ruficollis*) from Asia. These geese are chiefly interesting because they form the subject of one of the earliest drawings of birds, made nearly 5,000 years ago and found on the walls of an Egyptian tomb. A considerable demand exists also for such ornamental birds as swans, of which a large number are imported each year. One consignment this year included 152 European swans, and another 500 black swans from Australia. These birds are in great demand for parks, as the native species of American swans do not breed in captivity.

WILD-LIFE CONSERVATION IN ALASKA

Prior to the enactment of the Alaska game law of 1925 Alaska's fur and game had been administered under separate and inadequate laws. The stocks of all fur bearers and of some of the game species had been considerably depleted, and many had been so far reduced as to threaten their existence locally. A serious situation

was thus presented, for Alaska's big-game and fur mammals and its bird life rank among the most important of the natural resources of the Territory, and there are few sections that do not produce one or more of these valuable forms. Throughout most of the Territory trapping is one of the chief industries, and in large sections a human population could scarcely exist without reliance upon the native game animals and birds for food.

The Alaska Game Commission created by the new law has realized the importance of gaining public support for game and fur protective measures and has on all occasions emphasized the fact that the maintenance of an abundant supply of wild life is advantageous from every standpoint. It has also shown that under wise management large areas that would otherwise be unproductive can be made to produce indefinitely valuable annual crops of fur and game. The soundness of these principles has been very generally recognized, and giving them publicity undoubtedly has been an important factor in the splendid response to the program of better wild-life protection. The five members of the commission are residents of Alaska, and one, the administrative officer, is the chief representative of the Bureau of Biological Survey in the Territory. Administration of the law has been carried on by the commission with an exceedingly limited personnel, but it has been well supported by those interested in the development of Alaskan resources. Little opposition to its law-enforcement activities has been voiced; on the contrary, there are constant demands that more adequate wild-life protective measures be undertaken. Prosecutions of violators have resulted in an exceptionally high percentage of convictions, and substantial fines and jail sentences have been the rule. As a result, the sharp decline in wild life has been checked, and some forms are already being gradually restored.

The fact that the three Territorial legislatures meeting during the past six years have made substantial appropriations for the stocking of areas with valuable species of wild life evidences the progress being made in the development of conservation measures. The stocking program has been concerned primarily with transferring to suitable areas valuable species that are native to the Territory, such as beavers, muskrats, and other fur bearers, deer and other big game, and blue grouse, and also with the importation of buffalo and elk. Reports indicate that the herd of 23 buffalo shipped last year from the National Bison Range in Montana through the cooperation of the Biological Survey thrived on the natural food of the region and came through the winter in good condition. All but four of the buffalo were liberated in a favorable region not far from Fairbanks, and these four were placed at the reindeer experiment station maintained by the Biological Survey at College, where they could be kept under close observation.

Special investigations also were made by representatives of the Biological Survey and the Alaska Game Commission regarding big brown and grizzly bears in the Territory, particularly those of the Kodiak-Afognak Islands group of southern Alaska. Petitioners had cited the growing agricultural activities of these islands and the losses suffered by stock raisers through the depredations of the Kodiak bear, and had asked that all protection be removed from these giants of the wild so as to permit persons to kill them in any manner at any time of year. In line with the policy of the department on predatory-animal control, which, while designed to safeguard farming and stock raising, is opposed to the extermination of any of the interesting species of the wild life of the continent, new regulations were approved to give protection as formerly to these big bears as game animals, but with the proviso that on Kodiak, Afognak, and certain other islands residents engaged in agriculture may kill them when they are considered a menace to persons, livestock, or property. This has the effect of preserving in nonagricultural mountain areas what is known to scientists, sportsmen, and visitors to Alaska to be the largest carnivorous land mammal in existence. Had all protection been removed from this notable animal, thus opening the way for its eventual extermination, a heavy fire of justifiable criticism would have come not only from the many organizations and individuals who have in the past derived both sport and pleasure from their contacts with the Kodiak bears, but from the people of Alaska generally, for the big-game animals form a notable feature of

Alaska's wild life and also attract from the States and other countries many visitors whose expenditures for equipment, travel, personal services, etc., constitute what is by no means an inconsiderable contribution to the commerce of the Territory. The Biological Survey, through the Alaska Game Commission and the Office of Experiment Stations of the department, will keep in close touch with the situation to note further developments. The new regulations, together with other laws and regulations relating to land fur-bearing animals and birds in the Territory, were published as a circular (No. 6) of the Alaska Game Commission.

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